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ART. I. *A short Account of the Origin, Progress, and present State of the various Establishments for conducting Chemical Processes, and other Medicinal Preparations, at Apothecaries' Hall. (with a Plate.)*

FROM the charter granted to the Society of Apothecaries by his majesty King James the First, it appears that about the latter end of the sixteenth and the beginning of the seventeenth century, the metropolis of this kingdom abounded in ignorant and dangerous empirics, who, not being regularly educated as apothecaries, made and compounded many "hurtful, false, and pernicious medicines," the evil effects of which were not confined to the capital, but were disseminated through most parts of the kingdom. With a view to remedy these grievances the society was established in the year 1617, and was empowered to make ordinances concerning medicines and compositions, advising respecting the same with the president and censors of the Royal College of Physicians; also to examine the shops of apothecaries within the city of London, and to the extent of seven miles around it, with a view of ascertaining the qualities of the drugs and medicines contained in them, and with power to destroy all "unwholesome and hurtful articles" which they might discover during such examination.

It was soon found that the want of legislative authority ren-

dered the wise and judicious intentions of this charter nugatory, with respect to all such apothecaries who were not members of the society. Early and repeated applications were therefore made to parliament, for their sanction to confirm and establish the powers contained in it, but for various causes such sanction could not then be obtained ; so that the evils, which it was chiefly intended to obviate in the preparation of medicines, continued to an equal and probably greater extent.

From the records of the society, it appears, that its members soon discovered a laudable anxiety to relieve themselves from the necessity of depending for a supply of medicines on the artifices, and the spurious compositions of the druggists and chemists of that time, and accordingly, in the year 1623, they formed a plan for supporting a dispensary of their own, for compounding the more elaborate confections, (which containing a great number of ingredients were more liable to adulteration) by a public dispensation under the inspection and management of a committee of themselves. The utility of this plan, being probably confined to very few articles, must have been of a very limited extent, and it was not until nearly half a century after, that the design of a public laboratory for the preparation of chemical medicines was set on foot. It originated from the difficulty and great expense which must have been incurred, by the apothecary, in making his own chemicals, and from the impracticability of his procuring them elsewhere in a pure and genuine form.

In the year 1671, a chemical laboratory was first formed at Apothecaries' Hall, by subscription among the members of the society. When compared with the present very extensive establishment, it must certainly have been upon a small scale, but, no doubt, amply sufficient to answer the purpose for which it was then intended, which was to furnish the individual subscribers, and them only, with such chemical preparations as they might have occasion for in their medical practice as apothecaries.

How long the sale of chemicals was confined to subscribers alone cannot now be known, but the increasing reputation of this laboratory must have soon caused applications for purchasing

them from persons who were neither subscribers nor members of the society, for, in 1682, the committee of managers were called upon to consider the propriety of acceding to such applications. Whether it was at that time consented to, or not, does not appear, but it must have taken place within a few years after.

In the early part of the reign of her late majesty Queen Anne, a new era took place in the affairs of this society. So much difficulty had arisen in providing pure and genuine drugs and medicines for the use of the Royal Navy, and the credit of the society in their chemical preparations was so fully established, that application was made to them by his royal highness Prince George of Denmark, Lord High Admiral, to undertake that service, which was readily consented to, and became the origin of a separate commercial establishment under the title of the Navy Stock.

Until this time chemical processes only were carried on at their hall, but as it now became necessary to provide both drugs and their preparations, as well as the various galenical medicines at that period employed, a considerable capital was formed, and warehouses and laboratories erected for that purpose. The great expense attending the establishment of this stock, which, from the extensive erections of such various kinds, became unavoidable, rendered it for the first half century a source of small pecuniary profit to the proprietors. It is only subsequently to that period, that the numerous and extended wars in which the nation has been engaged, and the consequent large supplies of medicines required for the service of the navy, in addition to the great quantities exported to India, by order of the Honourable East India Company, and the large sums which have been of late years received for medicines furnished for public institutions, as well as private families, that a profit has accrued by which the society and its members have been indemnified for the losses and other disadvantages sustained in the infancy of this commercial establishment.

As the concerns of the society have been, at all times, conducted with that accuracy and integrity which has acquired for the medicines prepared at Apothecaries' Hall the highest character, both

throughout this kingdom and in almost every part of the globe, it will be right to give a general explanation of the manner in which the business is conducted, subjoining a short description of the present improved state of their laboratories and apparatus, and also of the several processes carried on in them.

The general management of the affairs of the society, as connected with the preparation of medicines, is under the immediate superintendence of committees, who meet four times in the week, or oftener when required, and some member of which attends daily and enters in a book the processes which he finds carrying on at the time of his visit. These daily attendances are performed by the members of the committees in rotation.

The *buying committee* meets every Tuesday at one in the afternoon, to examine and compare the samples of articles sent in by the druggists, and to direct their purchase; the articles wanting, and the quantity of each required, being specified upon a list posted up in the hall for the information of any merchant or druggist who may choose to offer samples to the committee. At these meetings, the best article being selected and determined upon, the chairman announces the name of the vender and the price, and the deputy chairman enters the order. Where two or more samples of the same article are equal in quality but vary in price, the cheapest is purchased; if the price of two or more equally good samples be the same, and the quantity required considerable, the order is generally divided, or given to that house from which the least has been purchased.

In this way every drug and other article required for the use of the society's trade is purchased exclusively by sample.

To ensure the correspondence of the bulk of the article delivered into stock with that of the sample, a distinct *Committee of Inspection* meets every Friday, for the purpose of comparing the bulk with the sample presented on the preceding Tuesday, and rejecting or receiving it accordingly. It is also an important duty of this committee to examine samples of all preparations whatever, coming from the laboratories, previous to their being disposed of in trade; samples, therefore, of all powders, tinctures, chemical

and other preparations, are regularly presented at this committee, and their qualities determined by inspection or experiment, when any faulty articles are rejected or returned for amendment, while those which are approved are entered as such, and ordered into the shops and warehouses.

The immediate business of the chemical laboratories as relates to the processes, operations, and apparatus, are under the control and inspection of the superintending chemical operator; and of the chemical and galenical operators who reside at the hall; and these officers constantly attend the buying and inspecting committees, and such other meetings of the directors of the establishment as may require their presence.

If any explanation be necessary of the prices charged by the Society of Apothecaries for their medicines, which are in some instances higher than those usually affixed to the same articles, even by respectable chemists and druggists, it will be only necessary to observe that the mode in which the business is transacted at Apothecaries' Hall, puts it out of their power to enter into competition with those persons in that respect for the reasons which follow:

The society consider it their duty to countenance and support the laudable designs of the Royal College of Physicians by adhering strictly to the directions of the Pharmacopoeia in the preparation of medicines, both as to the quality of the ingredients and the proportions in which they are employed. Moreover, their practice of purchasing none but select drugs, separated from those parts which are of a damaged or inferior description, compels them to give proportionably higher prices for them than are given by the wholesale trader, who either imports his own drugs, or purchases them in their original packages as imported, which he afterwards garbles and divides according to their respective qualities, and fixes his prices to the different purchasers accordingly.

The medicinal compositions which are most liable to adulteration, because the less easily detected, are extracts, confections, and tinctures. The ingredients of which these are formed, are for the most part very expensive, such as, among many others,

opium, cassia fistula, castor, colocynth, saffron, benzoin, guaiacum, scammony, cinnamon, cardamom seeds, but above all the cinchona lancifolia, or crown bark, which from the very high price it bears, from the large quantity of it which ought to be employed, and from the many inferior sorts of bark which may be purchased in some instances for not more than a sixth part of its price, affords a strong temptation to abuse, both in the quantity and quality of the article made use of; a temptation, which the most charitable judgment must suppose, in many cases, too strong to be resisted.

That there are chemists and druggists in the metropolis, from whom genuine drugs may be purchased, and by whom medicines are prepared with fidelity, is indisputable, but it may be feared that it is too often far otherwise. The advantage of low prices is a powerful inducement with medical practitioners, both in town, and particularly in the country, to purchase inferior medicines; placing that confidence in the vender of them, to which, they are perhaps not aware that he is not always entitled, and of the quality of medicinal preparations the practitioner himself is frequently an incompetent judge.

As superior excellence in the condition of the various materials employed in the preparation of medicines must be allowed to be of the greatest importance, and as it is a trust so liable to abuse, that it must ever be considered highly confidential, it is respectfully submitted that this advantage cannot be satisfactorily secured by any other method than that which has been constantly pursued by the Society of Apothecaries, namely, having no articles of inferior qualities in their possession, and, as far as is practicable, conducting all their processes within their own walls, and particularly that of powdering drugs in their own mills, by which a fruitful source of fraud must be effectually prevented.

After repeated solicitations, the Society have for a few years past, in addition to the general business carried on at their hall, opened a department for the sole purpose of preparing and compounding the prescriptions of physicians and others, which from the success which has already attended it, they are well satisfied will prove an acceptable enlargement of a system, the prin-

principal object of which, in all its branches, has been to provide the public with pure and genuine medicines.

Description of the Laboratories.

The principal laboratory is a brick building about fifty feet square and thirty high, lighted from above, and subdivided by a brick wall into two compartments, the dimensions of the larger one being fifty feet by thirty; and of the smaller fifty feet by twenty. The former may properly be termed the *Chemical Laboratory*, all the open fires and furnaces being situated in it, and all operations requiring intense heat being there conducted. The latter is usually termed the *Still-House*, all distillations and evaporations being performed there, exclusively by steam, which is furnished in a manner afterwards to be described, by a boiler placed in a small building annexed to the main laboratory.

Immediately connected with the above-mentioned building is a chemical warehouse for such articles as are in immediate consumption in the laboratory, above which is a small house for a clerk, the whole being shut off from the laboratory by iron doors.

The principal entrance to the chemical laboratory is through the *Mortar-room*, which is forty feet long and twenty-two broad, and appropriated to mortars, presses, and generally speaking to all mechanical operations performed by manual labour. At its eastern extremity is a large drying stove, heated by flues, for the desiccation of those articles which cannot be dried conveniently at temperatures easily obtained by steam. At the west end of this apartment a room twenty-two feet by fifteen is divided off, in which is an apparatus for the production of gas from oil, with which the hall and its various departments, both externally and internally, are lighted. Above the mortar-room is a gallery fitted with shelves for various utensils and apparatus, opening at one end into a room appropriated to the use of the labourers, and at the other, into the *Test-room*, a small laboratory fitted up with the requisite apparatus, for minute and delicate investigations, and in which chemical tests and other articles requiring peculiar attention and cleanliness are prepared.

Annexed to the gas-room is a counting-house, behind which a room twenty-two feet square, commonly called the *Magnesia-room*, is appropriated to the preparation of that article, and also to the manufacture of the most common saline preparations.

Such are the general arrangement and dimensions of the various buildings connected with or forming part of the chemical laboratories; in a detached building there is a steam-engine of eight horse power, which is employed with proper machinery, for grinding, sifting, triturating, pounding, and a variety of other operations, which it is not necessary at present particularly to advert to. There are also connected with the establishment, suitable warehouses, shops, and all other requisite conveniencies for carrying on an extensive trade.

In the construction of the new laboratory safety is ensured by the whole being fire proof, and it is ventilated by a series of apertures in the roof, which may be opened or closed at pleasure. The main chimney is erected in the centre, and has, opening into it below the pavement of the laboratory, four large flues, one of which enters upon each side of its square base. The shaft is one hundred feet high from the foundation, and is accessible in its interior from one of the under-ground flues. The flues of the furnaces which are placed against the walls of the laboratory are each supplied with registers, and open into a common channel, which surrounds the building, terminating in the chimney as already described. Each of the four large flues has also a separate register, which may be more or less closed or opened according to the operations which are going on in the various furnaces connected with it. The furnaces thus arranged are,

A subliming apparatus for benzoic acid.

A furnace for the preparation of sulphate of mercury.

A high pressure steam-boiler.

A reverberatory furnace.

A sand bath.

An apparatus for muriatic acid.

Ditto for nitric acid.

Ditto for the distillation of hartshorn.

A calcining furnace.

There are also a series of furnaces built against the sides of the main chimney, and communicating directly with it by flues of their own, which, as well as the common openings by which they enter the chimney, are supplied with effectual registers, so that when not in use they may be perfectly closed. Of these furnaces, four are chiefly employed for various sublimations, and fusions; four are retort pots; the third side of the chimney is occupied by a powerful wind furnace; and the fourth by a furnace for the sublimation of calomel. In this laboratory there is, moreover, a very copious supply of water, both hot and cold; and an engine-hose and pipe is always attached to the water main, in case of accident by fire, as well as for the purpose of cleansing the pavement. Beneath the building are extensive vaults for fuel, with which there is a direct communication by steps descending in one of the angles of the laboratory.

The *still-house* contains six stills of various dimensions and constructions, twelve pans, or boilers, and a drying stove, all of which are exclusively heated by steam, supplied from an eight hundred gallon copper boiler, placed in an annexed building, below the level of the still-house; and the flue of which, passing under the pavement of the laboratories, enters the main chimney already described.

The boiler is calculated to supply steam under a pressure of an atmosphere and a half, and is fed with hot water by a forcing pump kept in constant operation by the steam-engine. It is properly fitted with valves, and pressure and water gauges.

The main steam-pipe, after ascending from the boiler, sends off descending branches which ramify under the pavement of the still-house, in channels of brick-work, covered by cast-iron plates. These send off a steam-pipe, fitted with a register cock, to each still and boiler, from which there passes off an eduction or condensed water-pipe, entering the condensed water main, the ramifications of which accompany the steam main, and deliver their contents into a cistern, whence the boiler is supplied with hot water. A large branch of the steam-pipe circulates in five convolutions at the bottom of the drying stove, so as to heat a cur-

rent of air which is made to pass through it; and another branch, rising perpendicularly through the pavement, is properly fitted with cocks and screws for the occasional attachment of leaden or other pipes, for boiling down liquids in moveable pans and vessels.

In this building, one of the stills is of a distinct construction, and heated by high pressure steam, supplied from the boiler already mentioned in the description of the laboratory. Another still, together with its condensing pipe, is composed entirely of earthenware. The former is chiefly used for the first distillation of sulphuric ether, and the latter for that of spirit of nitric ether. The stills and vessels are generally heated by the circulation of steam upon their exterior, but sometimes serpentine pipes traversing the liquor are employed.

In the still-house all spirits and waters are distilled; extracts and plasters are prepared; and all operations are carried on which involve risk by fire, or in which damage is likely to occur from excess of heat.

The *Magnesia-room* contains proper vats and boilers for the production and evaporation of saline solutions; the apparatus for the precipitation of carbonate of magnesia; and a series of vessels for saturating alkalies with carbonic acid.

In the above outline it has been intended to shew that no labour or expense has been spared to render the chemical laboratories complete, and that all the important modern improvements in their construction have been adopted upon an extensive scale, rather than to enter into any particulars respecting the arrangement and dimensions of the vessels, furnaces and apparatus which they contain. These details will be found in the description of the annexed Plate representing the ground plan of the laboratories.

—See Plate.

ART. II. *Remarks on the Numerical Changes of the Population of Great Britain, as divided into the Classes of Agriculturists, Manufacturers, and non-productive Labourers, during the period from 1811 to 1821.* By George Harvey, Esq., M.G.S., M.A.S., &c. &c.

[Communicated by the Author.]

THE numerical changes which particular branches of a community undergo, in the progress of time, are to be classed among the most remarkable phenomena with which we are surrounded; and may be regarded as the ultimate result of that great chain of causes, which is in perpetual operation to alter and diversify the condition of man. In a society, exposed to the uncertain tide of political events, it is interesting to trace the mutations which some of its greater divisions disclose, as causes, more or less favourable, operate upon them;—how, for example, at one period, or in some particular districts, the manufacturing part of a community increases in numbers, in happiness, and prosperity; and how, at other times, and in other districts, indications of an opposite kind may be traced;—commerce imparting vigour at one season, and at another exhibiting only the feeblest influences of its power. So likewise the condition of an agricultural population changes; and shades of prosperity may be discovered in a singular variety of forms.

Such uncertainties must necessarily impart their influence to population. The principle of *subsistence*, which, without impropriety, may be said to govern and control all the primary movements of man, will operate as a perpetual stimulus, and compel him to migrate from one branch of a society, or from one country to another, until he finds a station suited to his wants.

To this principle may be referred the numerical changes which the three divisions of the inhabitants of Great Britain have undergone, during the period from 1811 to 1821. The divisions here alluded to are those prescribed by the Act for ascertaining the population; consisting, 1^o. of *families engaged in agriculture*;

2°. of families employed in trade, manufactures, or handicraft; and
3°. of all other families not included in the other classes*.

The magnitude and character of these changes are exhibited in the following tables: the first presenting the general results relating to England, Wales, and Scotland; the second to the particular conclusions deduced for the counties of England; and the third and fourth to the results obtained for those of Wales and Scotland.

Proportional change of 10,000 Families, chiefly employed

In Agriculture.	In Trade, Manufactures, or Handicraft.	Otherwise than the two preceding Classes.
GENERAL RESULTS.		
England . . . -168	England . . . +175	England . . . - 7
Wales . . . -555	Wales . . . + 63	Wales . . . +492
Scotland . . . -211	Scotland . . . + 33	Scotland . . . +178

ENGLAND.

Rutland . . . +432	Stafford . . . +731	Durham . . . +518
Northampton . . +400	Derby . . . +609	Worcester . . . +404
Buckingham . . . +235	Westmoreland . . +591	York, N. Riding . +343
Salop . . . +192	Sussex . . . +563	Norfolk . . . +283
Huntingdon . . . +102	Cornwall . . . +557	Hertford . . . +252
Oxford . . . + 79	York, E. Riding . +539	Devon . . . +233
Lincoln . . . + 69	Monmouth . . . +517	Northampton . . +231
Kent . . . + 65	Warwick . . . +450	Buckingham . . . +227
Suffolk . . . + 50	Surrey . . . +425	Cumberland . . . +175
Dorset . . . + 49	Lancaster . . . +421	Chester . . . +169
Essex . . . + 47	Northumberland . +384	Somerset . . . +169
Southampton . . - 9	Huntingdon . . . +322	Wilts . . . +168
Berks . . . - 21	York, W. Riding . +265	Bedford . . . +133
Westmoreland . . - 22	Cambridge . . . +197	Southampton . . +130
Surrey . . . - 28	Gloucester . . . +146	Nottingham . . . +120
Cambridge . . . - 36	Berks . . . +140	York, W. Riding . + 87
Middlesex . . . - 50	Essex . . . +132	Kent . . . + 72
Devon . . . - 78	Lincoln . . . +107	Leicester . . . + 72
Hereford . . . - 88	Leicester . . . +106	Hereford . . . + 30
Somerset . . . - 89	Cumberland . . . +101	Gloucester . . . - 10
Hertford . . . -122	Middlesex . . . + 63	Middlesex . . . - 13
Norfolk . . . -125	Hereford . . . + 58	Suffolk . . . - 26
Nottingham . . . -128	Oxford . . . + 50	Dorset . . . - 34
Bedford . . . -128	Durham . . . + 49	Lancaster . . . -100
Gloucester . . . -136	Chester . . . + 32	Sussex . . . -103

* In the Act of 1801 relative to the population, the inquiry related to *persons*, and not to *families*. This led, however, to so many ambiguities and uncertainties, that the very accurate author of the Preliminary Observations to the Population Returns for 1821, observes, that it "was found in practice to produce no valuable result." This was corrected in the Acts of 1811 and 1821; and the results now appear to merit considerable attention.

Proportional change of 10,000 Families, chiefly employed

In Agriculture.	In Trade, Manufactures, or Handicraft.	Otherwise than the two preceding Classes.
ENGLAND continued.		
Wilts -178	Wilts + 10	Berks -119
Leicester -178	Nottingham . . . + 8	Oxford -129
Cornwall -182	Bedford - 5	Monmouth . . . -141
York, E. Riding . -186	Dorset - 15	Salop -148
Chester -201	Suffolk - 25	Warwick -157
Northumberland . -218	York, N. Riding . - 43	Cambridge . . . -161
Worcester -222	Salop - 44	Northumberland . -166
Cumberland . . . -276	Somerset - 80	Rutland -170
Stafford -278	Southampton . . -121	Lincoln -176
Warwick -293	Hertford -130	Essex -179
York, N. Riding . -300	Kent -137	Derby -233
Lancaster -321	Devon -155	York, E. Riding . -353
York, W. Riding . -352	Norfolk -158	Cornwall -375
Monmouth -373	Worcester -182	Surrey -397
Derby -376	Rutland -262	Huntingdon . . . -421
Sussex -460	Buckingham . . -462	Stafford -453
Durham -567	Northampton . . -361	Westmoreland . . -569

WALES.

Cardigan + 38	Brecon +1277	Carmarthen . . . +1553
Flint - 29	Cardigan + 378	Glamorgan . . . +1017
Radnor - 75	Denbigh + 290	Carnarvon + 872
Denbigh -316	Pembroke + 285	Anglesey + 833
Merioneth . . . -404	Flint + 239	Montgomery . . . + 562
Pembroke -524	Montgomery . . . + 150	Merioneth + 297
Carnarvon . . . -542	Merioneth + 107	Pembroke + 239
Anglesey -679	Radnor + 39	Brecon + 139
Montgomery . . -712	Glamorgan - 130	Radnor + 36
Glamorgan . . . -887	Anglesey - 154	Denbigh + 26
Carmarthen . . . -907	Carnarvon - 330	Flint - 210
Brecon -1416	Carmarthen - 646	Cardigan - 416

SCOTLAND.

Clackmannan . . + 499	Caithness . . . +1903	Renfrew +1276
Kircudbright . . + 244	Clackmannan . . +1711	Inverness . . . +1138
Renfrew + 204	Edinburgh + 610	Lanark +1047
Edinburgh . . . + 185	Haddington . . . + 535	Orkney + 878
Fife + 118	Bute + 533	Selkirk + 812
Berwick + 104	Wigton + 520	Dumbarton . . . + 667
Argyll + 64	Ross + 473	Fife + 449
Dumfries + 22	Sutherland . . . + 462	Sutherland . . . + 257
Bute - 35	Elgin + 430	Nairn + 230
Ross - 40	Banff + 424	Perth + 196
Stirling - 43	Ayr + 351	Berwick + 144
Dumbarton . . . - 89	Nairn + 326	Dumfries + 144
Forfar - 98	Roxburgh + 297	Kincardine . . . + 113
Linlithgow . . . - 105	Kirkcudbright . . + 275	Wigton + 32
Kinross - 107	Aberdeen + 253	Roxburgh + 15
Ayr - 175	Forfar + 243	Argyll + 14
Aberdeen - 186	Linlithgow . . . + 240	Peebles - 11
Elgin - 192	Kinross + 212	Aberdeen - 67
Peebles - 196	Peebles + 207	Stirling - 73
Banff - 232	Kincardine . . . + 199	Caithness - 101
Kincardine . . . - 312	Perth + 137	Haddington . . . - 102

Proportional change of 10,000 Families, chiefly employed

In Agriculture.	In Trade, Manufactures, or Handicraft.	Otherwise than the two preceding Classes.
SCOTLAND continued.		
Roxburgh . . . - 312	Stirling . . . + 116	Kinross . . . - 105
Lanark . . . - 319	Orkney . . . + 106	Linlithgow . . - 135
Perth . . . - 333	Selkirk . . . + 95	Forfar . . . - 145
Inverness . . - 416	Argyll . . . - 75	Ayr . . . - 176
Haddington . - 433	Dumfries . . - 166	Banff . . . - 192
Wigton . . . - 552	Berwick . . - 248	Elgin . . . - 238
Nairn . . . - 556	Fife . . . - 567	Ross . . . - 433
Sutherland . - 719	Dumbarton . - 578	Bute . . . - 498
Selkirk . . . - 907	Inverness . . - 722	Kirkcudbright . - 519
Orkney . . . - 984	Lanark . . . - 728	Edinburgh . . - 795
Caithness . . -1802	Renfrew . . -1480	Clackmannan . -2210

To facilitate comparison, the total population of each county has been assumed at 10,000 families; and from this radix, the proportional number of families for each of the classes has been deduced by a simple numerical operation, from the absolute population recorded in the returns for 1811 and 1821. The *difference* between the results thus obtained for the two periods, in each county, produced the results given in the preceding tables; and which are so arranged, as to present, for one extreme, the maximum of increase, and for the other, the maximum of decrease; the intermediate steps indicating by their proper signs + or —, the increments or decrements of the respective counties, according as their respective divisions have been augmented or diminished. As an example, to prevent a misconception of the tables, it may be added, that during the ten years from 1811 to 1821, the agricultural population of Norfolk has *diminished* in the ratio of 125 families to 10,000; the county of Hereford has *increased* its manufacturing population in that of 58 families to 10,000; and Suffolk *decreased* the class of its non-productive labourers, 26 families out of the same number.

By a reference to the table of general results, it will be perceived, that the aggregate agricultural population of England, Wales, and Scotland, has diminished; but that the families employed in trade and manufactures have increased. The third, or unproductive class, has received a small diminution in England, but in Wales and Scotland they have been augmented, and in the former con-

siderably. Of the agricultural population it may also be observed, that Wales has undergone a greater diminution than either those of England or Scotland; and the classes of its unproductive labourers has likewise received the greatest augmentation. The feeble diminution also of the last-mentioned class for England, is worthy of particular remark; and from the manufacturing population having received an increase somewhat analogous to the depression of the class of agriculturists, it may be inferred, that during the ten years from 1811 to 1821, the class of artisans derived its increments from that of agriculture; the demand for labour having been more active in the former division than in the latter. The increments also, which the manufacturers of Wales and Scotland have received, may be properly attributed to the same source. The most important feature of the table of general results, and that indeed which deserves the most serious attention, is the great diminution of the agricultural population.

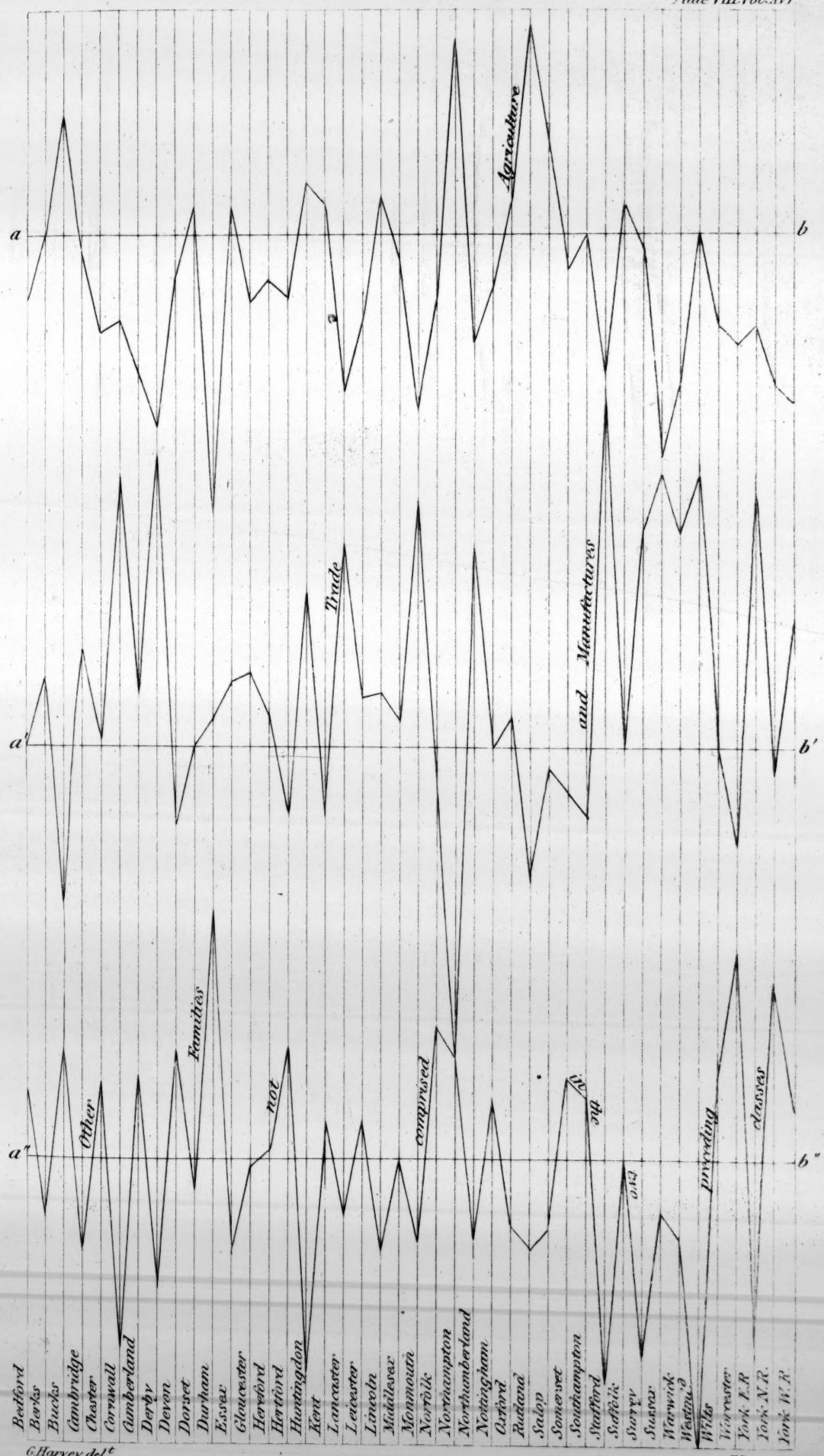
Of the individual counties it may be observed, that for agriculture, the maximum increase is in Rutland; for trade and manufactures in Stafford; and for the third, or unproductive class, in Durham. The latter county also presents the maximum decrement for agriculture; Northampton for manufactures; and Westmoreland for the unproductive class. The counties of Wilts and Leicester approach the nearest to the actual state of the aggregate agricultural population; and Gloucester, for the two succeeding classes. The county distinguished by the least change in its agricultural population is Southampton; and for the minimum change in its manufacturers, Bedford; and for its third, or unproductive class, Gloucester. The forty English counties, having each of the three classes divided into the general denominations of increments and decrements, are respectively, in point of numbers as follows:

Agriculture.	Trade, Manufactures, or Handicraft.	Otherwise than the two preceding Classes.
Counties	Counties	Counties
Increments . . 11	Increments . . 26	Increments . . 18
Decrements . . 29	Decrements . . 14	Decrements . . 22
Total . . 40	Total . . 40	Total . . 40

To give a more perfect idea of the great fluctuations which the three established divisions of the English population have undergone during the period under consideration, is the object of plate VII. The lines *ab*, *a'b'*, *a''b''*, may be regarded as lines passing through zero, or a common origin, and to which all the changes indicated in the preceding tables are referred. Those portions of the waving lines *above* those which denote the common origin of the changes, represent the counties distinguished by increments; and those *below*, the different decrements. The sums of the lines indicating the changes for each county, must obviously amount to the same constant quantity. The counties are arranged alphabetically, and not in the order in which they are recorded in the tables.

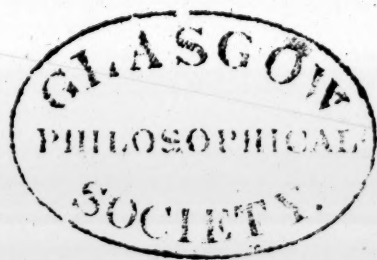
By contrasting the lines denoting the different changes with each other, it will be immediately seen how one is, in some measure, regulated by the other; how, for example, if a county as Cumberland, has *positive* changes in the second and third divisions of its population; how the class of agriculturists is immediately distinguished by a *negative* change, equal to the sum of the preceding; or how, if like Monmouth, the first and second classes are contrasted, and their variations are of an *opposite* kind, how the third class undergoes a change, equal to the *difference* of the two; partaking of a *positive* or *negative* character, according to the nature of the greater. The maximum increments and decrements are also clearly displayed in it; and likewise those counties in which the changes of their population have been the least.

In Wales it will be observed, that with the exception of Cardigan, the agricultural population of all the counties has diminished; and it is also remarkable, that the decrements in general are superior in magnitude to those of England. The numerical results also for the unproductive labourers in all the counties, excepting Flint, have signs precisely the reverse of those attached to the class of agriculture; proving that the former counties have gained accessions, partly, at least, from the latter. Cardigan having increased both its agricultural and manufacturing population, has diminished its unproductive members. Carmarthen, on the contrary, has



C. Harvey, del.

J. B. B. sc.



increased the latter class of persons from the other two classes, and most particularly from that of agriculture. The same remark applies also to Glamorgan, Anglesea, and Carnarvon. The last-mentioned county is also that which approximates the nearest, in the state of its agricultural population, to that of the aggregate population of the principality; the same being found to be the case in Radnor, for trade and manufactures; and in Montgomery, for that of the unproductive labourers.

Of the thirty-two counties composing Scotland, it may be remarked, that eight are distinguished by an increase of their agricultural population, and twenty-four by a diminution thereof; but of the population devoted to trade and manufactures, twenty-four counties have received increments, and the remaining eight decrements. Sixteen also of the counties have received an augmentation to their non-productive members, and the remaining number a diminution.

The magnitudes of the numbers indicating the extreme changes may considered as remarkable, when contrasted with the corresponding results for England. Caithness, for example, is distinguished by an increment to its manufacturing population of + 1903, and by a decrement to its agricultural members of - 1802. Renfrew has also increased its non-productive members by + 1276, and Clackmannan diminished the same class by - 2210. The county distinguished by the least change in its agricultural population is Dumfries; Selkirk in its families devoted to trade and manufactures, and Peebles in the class of its non-productive members. The families devoted to agriculture in Peebles, approach also the nearest to the change of the aggregate population of the first class; Selkirk also in its trading and manufacturing, and Perth in its non-productive, members, to the respective changes in the aggregate members of the corresponding classes. Caithness presents also an example of a remarkable decrement in its agricultural population, and of a more considerable increase in its manufacturing members; but only a very moderate decrement in its negative members. Clackmannan likewise has very rapidly diminished the latter class, increased in a very great degree its

manufacturers, and received a small increase in population. Inverness presents also an instance of considerable declensions in its agricultural and manufacturing members; and an increment equal to both the preceding decrements, to its unproductive families. A similar remark applies also to Dumbarton and Lanark. The declension of the manufacturing families in Renfrew, and their probable change into the unproductive class, likewise merits attention.

By an inspection of this part of the table, it appears that the aggregate of the *increments* for agriculture, amounts to 1437; whereas that of trade and manufactures is 10,658, the *latter* exceeding the *former* in a greater ratio than that of 7 to 1. The aggregate of the *decrements* of agriculture amounts also to 9,143, and that of trade only to 4,564; the former exceeding the latter in the ratio of 2 to 1.

ART. III. *On the Herring*, By J. Mac Culloch, M.D., F.R.S.

THE natural history of the animals useful to man, is not merely an amusing pursuit, but forms one of the most valuable branches of this department of knowledge. Yet it has been the blame of naturalists to have too much neglected this branch of their science, in their attention to classification and nomenclature. If there are not many of the wild or still undomesticated animals from a knowledge of whose habits we might derive advantage, there are still some that are loudly calling for this kind of investigation. From the state of ignorance that we are still in respecting these, we are not only forfeiting advantages which we might secure, but are also subject to serious losses and frequent disappointments.

This is peculiarly true of the herring. The following remarks will show, not only what advantages we might derive from an accurate acquaintance with the natural history of this fish, or with what may be called its moral and political history, but demonstrate the heavy losses in a commercial view, which have been the consequence, not merely of this ignorance, but of false theories on

that subject. If it is difficult to acquire this knowledge, we must recollect that nothing remains long impossible to industry and observation. That nothing rational has been yet attempted, is equally a stimulus and an encouragement; nor do I know of any department of this branch of natural science, whence an industrious naturalist might derive more honour, with the additional satisfaction of having conferred solid and important benefits on mankind.

The respect due to Pennant's name, will not permit us to speak lightly of him; yet, on this subject, he seems to have either given way to the influence of his imagination, or to have copied without inquiry from the works of others, what deserves nothing but the name of a pure romance. The readers of his work on *Zoology* must be aware of the theory to which I have given this name. Yet I am uncertain if it originated with himself, or with Anderson the historian of Greenland and Iceland. Since it is necessary however that it should be stated, as the foundation of this brief sketch, I shall give the most condensed view of it that I can, from the latter author. It is marvellous that such a tale should have been copied and quoted, and reprinted, not merely by the herd, but by the careful authors of the French Encyclopædia; and that, thus transmitted, it should not only have been believed for half a century or more, by those who, if they had reflected for an instant, or even opened their eyes, must have seen that it was a fable, but that it should have been the foundation of numerous expensive commercial establishments, standing to this day as testimonials of the fiction of one party, and the credulity of others.

Anderson commences by saying that, in Iceland, the herrings are two feet in length; which is a preliminary worthy of what is to follow. Every summer, he proceeds to say, an army of these fish leaves those northern regions, being chased southwards by whales, grampuses, sharks, and other large predatory fishes. As this army proceeds to the south, it divides into two columns; the eastern one making for the North Cape, and descending along the coast of Norway. This eastern wing, however, divides itself again into two other columns; one of these entering through the Sound into the Baltic, and the other proceeding for the point of Jutland.

This latter again splits on that point into two lines, one of which defiles along the eastern shore of Denmark, and then entering the Belts, reunites itself to the Baltic division; while the other, coasting Heswick, Holstein, Bremen, and Friesland, enters by the Texel into the Zuyder Zee, so as again to return into the north sea.

The second grand division of the original army, which had taken to the westward, is, according to this naturalist, the largest of the two. It proceeds straight for Shetland and Orkney, and thence goes on to Scotland. Here it divides, like the former eastern column into two divisions, or subsidiary columns, one of which proceeds down the eastern coasts so as make the round of England by the British channel, while at the same time it detaches parties into the harbours of Friesland, Holland, Zealand, Brabant, Flanders, and France. The western division, during this time, separates itself again in such a manner as to visit the coasts of Ireland and the western lochs of the Highlands, producing the Irish and Highland fisheries; visiting also the Isle of Man, where the herring fishery is notably abundant. In its further progress, this Irish and Highland army reaches the land's end, and here finally reunites itself to the eastern one whence it had separated, meeting it at the entrance of the channel. Thus reunited, the great original western division of the entire northern army, makes a rendezvous in the Atlantic, where, it must be supposed, they take an account of the killed and missing, before they return again to Iceland and the Polar seas, to renew the same march in the following summer.

It is sufficient to read this account to perceive, even without evidence to the contrary, or an examination of the subject, that it must be a pure romance. It is plain, *à priori*, that there are no means of ascertaining such a series of facts, nor even of approximating to a much less detailed history than that which is here given; even admitting that the basis of the extravagant superstructure were true. The few facts that I have to offer, will demonstrate that it is an entire vision. That the herring is, to a certain degree, a migratory fish, may be true; but even a much more limited migration than this is far from demonstrable. It is at any rate perfectly certain that it does not breed exclusively in the

Arctic seas, and that it does not, as the author and Mr. Pennant imagine, migrate "heaven directed" to our shores. It is equally certain that it does not take the directions here described along them, that there is no such progress along the east and west coasts from a central point, and no such reunion at the Land's end. It is no less certain that its appearance, instead of being thus regular and constant, is quite the reverse, and that it is marked by extreme irregularity, as well for the period, as for the places visited. Of the imaginary original eastern army, I do not pretend to know much: the few remarks I have to offer, refer principally to the western or supposed Scottish column.

With respect, in the first place, to the original breeding station of the herring, the statement is unsupported by any evidence. We have no actual reports respecting their breeding or abundance in the northern seas. I cannot find that they have been remarked as abounding in the Arctic ocean, nor that they have been observed in the proper icy seas. They have never formed a fishery either in Greenland or Iceland: nor have our whale fishers taken any particular notice of them. It is a pure error to suppose that the great northern whale feeds on them. That fish is incapable, from the structure of its œsophagus and mouth, of swallowing so large a fish; and its food is well known to consist of minute shrimps, beroes, clios, and other marine worms and insects, among which the cancer pedatus and oculatus appear to be the most remarkable. The whale which pursues the herring on the Scottish coasts, is the piked, or bottle-nosed whale; an animal of very different anatomy and habits.

On the subject of the imaginary eastern army, all that appears to have been ascertained relates to the Swedish and Norwegian fisheries. The herrings were first noticed on the coasts of Sweden in 1740, and at that period the Gotheburgh fishery was established. The herrings were also abundant on the coasts of Norway before 1790. After that date they deserted those, and made their appearance at Marstrand. So far also from this visit having been among the first, which it should have been according to Anderson's state-

ment, they did not appear till November, when the Swedish fishery commenced. The produce also was so abundant, that in the short space of three weeks it amounted to 600,000 barrels. Since that period, however, they have deserted this coast.

This statement is sufficient to show the fallacy of the imaginary visit and progress of the eastern division of the equally imaginary Arctic herrings ; and I may now inquire respecting the supposed western one that appears on our own shores.

Now, so far are they from being migratory to us from the north, that there can be no doubt of their breeding on our own coasts. Yet the period of breeding, no less than the time of their visits, seems as irregular as every thing else that belongs to this apparently most capricious fish. That they do breed with us, is proved by their spawn being taken on many of the coasts where the full grown fish is found : and if that has not been found on all, it probably depends, partly on want of observation, and partly on the regulation for the minimum size of the herring nets. In Orkney, in 1699, an immense quantity of herring spawn was thrown on shore during some tempestuous weather ; proving that they then bred there. Yet, for a long period, they have entirely deserted the coasts of Orkney and Shetland : and it is only within three or four years that the Orkney fishery has recommenced. This circumstance marks a change of haunt and of spawning-places, but not a migration of the full-grown fish ; and is plainly inconsistent with any progress from the northward. Had they migrated in the manner stated, they must necessarily have appeared in Shetland and Orkney every year, while they would also have appeared there first, instead of being, as is the fact, utterly unknown about the former islands.

It is difficult, or rather impossible, to account for their thus changing the places of their spawning, not only in these islands, but upon the British coasts in general ; but these very changes of haunt prove also that they have no more any fixed rules for it than they have fixed migrations. Whether they did always spawn in these places where they were formerly abundant, cannot

now be ascertained. But it is probable ; partly from the fact just related of Orkney, and partly because, before the mesh regulation, they used to be taken of all sizes by the country fishermen.

Of these changes of place, the few following will be sufficient example and proofs. In the time of Charles I., and long afterwards, the Long island was their great resort ; and at Loch Maddy alone in North Uist, 400 sail of vessels have been loaded in one season. These last events were about the beginning of the last century. At the prior period which I mentioned, buildings were erected in this inlet, and a regular fishery established ; but they have long since deserted, not only this spot, but all the shores of the Long island. It is scarcely now even remembered by the people when they last appeared in any quantity.

From the beginning of the last century, for a considerable period onwards, their chief resort was about Loch Ewe, Loch Torridon, and, generally speaking, to the northern lochs of the west coast. About the same period they were then also abundant on the coasts of Sky. This state of things is well remembered, and it lasted for a long time. It is well remembered because it was the cause of much writing ; finding its way into such popular works as Goldsmith's light essays, and producing as many pamphlets and as much talk as politics have done at other periods. The poet Aaron Hill, was then entrusted with the direction of one of these fisheries, and if I mistake not, one of Mrs. Charlotte Smith's novels was written in Sky, from a similar connexion on the part of her husband. It is even better remembered by those who sank large sums in this vast speculation. Hence were erected the enormous establishments at Loch Torridon, at Martins' island, and on Tanera, now long become useless ; and the anticipations founded on it equally led to the establishment of Steen and Tobermory, and of other towns which have long ceased to make any progress, partly from the desertion of the herring shoals, and partly from the wrong principles on which the Fishery Society proceeded. I may here also remark, that in 1700, when they were abundant in Sky, it was ascertained that they bred there.

These are the losses to which I alluded at the commencement of this paper, which were caused by false views of the proceedings of the herrings. I do not know how far these establishments originated in the Arctic Theory, because some of them are prior, at least to the publication of Pennant's opinions: but it is very certain that many of the more recent ones proceeded on this foundation, believing that the migration of the herring was steady and certain. Nothing else could have led to the sinking of so much capital; the nearly total loss of which has been the result of this false information, or theory, and inconsiderate expenditure.

To pursue this part of the subject; at a later period, they seem to have preferred the lochs further to the south. Thus Loch Hourn and Loch Nevish became the great fishing stations, as did the Sound of Sky. But, warned by their preceding failures, no buildings were erected in these, and the fishery was managed by means of boats and busses in the present method. Thus also they made Loch Fyne one of their principal resorts, moving in a great measure towards the Clyde, or further south; though it also happened that they were abundant in these lochs, and also in the neighbourhood of Sky at the same period. Thus Portree, Scalpa, Loch Hourn, Loch Ransa, and Loch Fyne, have, within a few years, been the great resorts; yet very irregularly: and in this manner has Campbell town, which depends chiefly on the herring fishery, fluctuated between wealth and bankruptcy. For a single season, not many years ago, Loch Scavig in Sky was crowded with them in a manner perfectly incredible. Yet, before and since that period, they have been unknown there; marking in a very pointed manner, the extreme irregularity and caprice of their movements. All these seem mere changes of haunt, unconnected with any particular migration, and for which no causes can at present be assigned.

Vulgar philosophy is never satisfied unless it can find a solution for every thing; and is satisfied, for this reason, with imaginary ones. Thus, in the Long island, it was asserted that the fish had been driven away by the manufactory of kelp; some imaginary coincidence having been found between their disappearance and

the establishment of that business. But the kelp fires did not drive them away from other shores, which they frequent and abandon indifferently without regard to this work. It has been a still more favourite and popular fancy, that they were driven away by the firing of guns; and hence this is not allowed during the fishing season. But this, like the former, is *causa pro con causa*. A gun has scarcely been fired in the Western islands, or on the west coast since the days of Cromwell; yet they have changed their places many times in that interval. In a similar manner, and with similar truth, it was said that they had been driven from the Baltic by the battle of Copenhagen. It is amusing to see how old theories are revived. This is a very ancient Highland hypothesis, with the necessary modification. Before the days of guns and gunpowder, the Highlanders held that they quitted coasts where blood had been shed: and thus ancient philosophy is renovated. The steam-boats are now supposed to be the culprits; since a reason must be found. To prove their effect, Loch Fyne, visited by a daily steam-boat, is now their favourite haunt; and they have left Loch Hourn and Loch Torridon, where these have never yet smoked.

The recent and present state of the eastward fishery will furnish facts equally at variance with any theory of the herring; and as it is only by collecting and comparing these that we can form any hopes of attaining a true one, I may state the more important particulars.

In former times, the fishery of the east coast did not commence till that on the west had terminated. It was then supposed, and not very unreasonably, that the fish had changed their ground, and that these were the western herrings. Yet it ought to have been plain that this was not the case, as the eastern fish were entirely different in quality from the western, and very far inferior. At the same time, they were in that condition as to spawning, which proved that they could not have been the same fish. The fact of their being entirely different fish is now at least fully proved, because on both shores the period of the fishery has been the same. It is remarkable also that the eastern fishery has become so abun-

dant, as quite to have obscured the western ; while the quality of the fish has also improved, although they continue to be still far inferior. In 1820, this eastern fishery was so abundant as to have overstocked the whole market, foreign and domestic ; procuring considerable loss to the merchants, and materially checking its future progress. It is further to be remarked in this case, that so far from there being any indications of a progress from the north, the fishery has commenced soonest on the southern parts of this shore ; and, what is also remarkable, that for some years since that, it has become later every year. Of its actual state I cannot speak precisely, because my observations terminated with 1821.

I might extend the same kind of remarks to the English fisheries, but it is unnecessary. That of Yarmouth, and that of the Isle of Man, are among the most steady. A few years ago, they were taken in such abundance for the London market on the coasts of Kent and Sussex, that they could not be consumed, and were employed as manure ; and other changes equally unintelligible have occurred on the eastern and southern coasts of England, as well as the north shore of Cornwall.

That this capricious conduct is not peculiar to the herring, is proved by the recent state of the Pilchard fishery of Cornwall, and by the changes which the Sardinian fishery of Britany has undergone. The almost entire desertion of this fish from the former country, where it had been annual and abundant to a proverb, forming a steady and valuable object of commerce, is as yet unaccounted for. Lately, it has shewn symptoms of again returning.

It seems at any rate perfectly ascertained with respect to the herring, that it breeds on our own shores ; and this is the important point which the preceding remarks serve to ascertain, though they yet leave the changes of place unaccounted for. It seems to reside permanently in the deep surrounding seas, and apparently round the whole island, though more abundantly to the northward. This is clearly proved by the Dutch fishery, which was carried on at all times in the deep sea, and constituted that very fishery which was supposed to have produced to Holland such enormous wealth, and which excited our jealousy, and stimulated

our attempts. This was well known in Pennant's time, and long before, since it is a fishery of a very ancient date ; and it ought to have prevented the promulgation of the absurd theory which I have here contested. It is now equally known to ourselves, from our own deep sea fishery ; though that is comparatively little pursued, for reasons which will appear hereafter.

The approach to the shores is performed, in the first place, for the purpose of spawning, as this operation can only be carried on in shallow waters ; and hence the resort of the fish to the lochs and bays. It is probable also that the pursuit of food is another reason or motive ; and, among that food, we may reckon the medusæ and other analogous marine vermes, which are produced in such abundance during the summer, in all these shallow seas. Nor is it unlikely that the herrings are driven in to the coasts by their enemies, the piked whale, the grampus, and the fin-fish, as well as by the cod and other smaller fishes that make prey of them.

If all these motives variously combined will not account for their irregularity, they may at least aid in doing so. Hence, its haunts, as well as its periods may vary. That the season of spawning in different fish takes place at different periods, is apparent from the different states as to fulness in which these are taken at the same time. Hence the periods of their approach to the shores must vary, and hence also the full growth of the young fish must be established at different periods. As to the food, the season and place in which that is produced is known to vary, as does its abundance ; and this, unquestionably, must be one of the powerful motives by which their appearance both as to time and place is regulated. The appearance of their great enemies is no less uncertain, and thus also we approximate somewhat nearer to the causes of all these variations. Since there is reason to believe that the herrings feed on the medusæ, and as the presence of these is known by the luminous state of the water, it is very likely that this might, in itself, form some guide to the fishermen for their presence. But as they have not hitherto been aware of the cause of the luminous state of the water, this indication has been neg-

lected. In many seasons, the waters of particular bays are highly luminous, and crowded with these animals ; while, in others, they are utterly wanting. We might expect that the presence of the herrings would vary accordingly ; but though I have thus observed it, the observations have not been sufficiently repeated to allow of establishing a general rule.

I have already remarked that the season of spawning is apparently uncertain and various, and this seems confirmed by the discordant opinions of the fishermen on this subject. It seems, at any rate, to be fully ascertained, that they spawn in the same lochs where they are taken. The herring spawn abounds in these places in the season of the fishery ; and, with small nets, fish of all sizes are taken. The spawn is also then devoured by cod, coal fish, and others which follow them ; as they are in great abundance by the sea birds, particularly by the smaller gulls and the terns, which may be constantly seen flocking above the shoals, as the shoals of coal-fish are also found following them. Thus also they are found round the shores of the Isle of Man ; and hence it appears that the proper season of the herring fishery in the lochs, is that in which they arrive for the purpose of spawning ; and hence the condition in which they are taken. The young also seem to haunt the seas and bays where they have been produced, till they are full grown ; but they are now seldom taken under the full size, on account of the strictness with which the law for destroying the small meshed nets has been enforced. The fish which has spawned returns to the deep sea to recruit itself ; and thus the shotten herring, as it is called, is seldom taken.

It is further evident that the season of spawning must vary on different shores, because, at the same time, the fish is taken in different conditions on different shores, or is found at far distant times in the same condition. This happens comparatively on the east and west coasts of Scotland ; as it does in comparing the west coast, or the Isle of Man, with the eastern coast of England. It would be very important for the fisheries to ascertain the exact season of spawning for each place, on account of the great difference in the goodness of the fish according to the condition in

which it is taken. Independent of this, the herring is always in a much higher state of feeding on the west than the east coast, and is also much superior in size, flavour, and quality. In point of flavour, indeed, it is scarcely the same fish; being as much superior as a salmon is to the worst sea trout. This difference, in itself, would be enough to prove that no migration took place from the west to the east coast. I may add to the confusion which belongs to this subject, what I do not pretend to solve; namely, the various conditions as to fulness in which the herring is taken in the same place and at the same time. We might perhaps conclude from this, as from the other facts stated, that the season of spawning is very uncertain, and that, in this case, different tribes of fishes, or different fish, had been intermixed.

It appears to be a further proof against any migration of herrings in a body, even from the deep seas to the shores, that when they first arrive, and for the apparent purpose of spawning, they are not in shoals. They cannot then be taken by nets, from their dispersion. But the Highlanders then fish for them with a feather or a fly, and a rod, and, by this very amusing fishery, they take them in sufficient quantity to render it a profitable occupation; as one man has been thus known to take a barrel and a half, or about 1200 fish, during the few days this fishery lasts. It is thought that they again disperse after spawning before they collect into shoals, so as to give cause for a second fishery of the same nature.

Such are the principal facts which I have been able to collect, respecting the natural history of the herring, and the physical history of the fishery on the coasts of Scotland. Having had but slender opportunities of observation or inquiry, no other apology is needed for not having done more. I believe there is much more knowledge dispersed among the fishermen, for him who might have opportunity and dexterity to extract it. The people observe; but having neither system, nor interest to record, their knowledge is forgotten or neglected, even by themselves. He who should bestow his attention on this subject, for a few summers, might probably attain a knowledge of the most important facts yet remaining, and complete what I have only sketched.

It is the duty of the Board of Fisheries to add this to their other exertions ; and if that has not yet been done, it is perhaps because it has been thought sufficiently known, or, possibly, because it is supposed unattainable. It cannot be supposed unimportant ; and that it is neither of all these three, I hope I have proved. At least I have justified the criticism with which I commenced on the theory of Anderson and Pennant. It will not be uninteresting to add a few words on the present commercial and political state of the Herring Fishery.

That fishery, so long a subject of anxiety and speculation and regulation, has now arrived at a state more extended than was so long wished for, and so long despaired of. It has occasionally exceeded the demand ; and in 1820, it considerably and injuriously overstocked the entire market. It must be known, at least to those who have attended to the history of our commerce, that our anxiety about this branch of trade was excited by our jealousy of our neighbours the Dutch, who were represented as raising gold from the mines of the ocean, and as infringing on our rights and property ; insulting our indolence at the same time by their superior industry. I may refer to the pamphlets and newspapers, almost to the romances and poetry of the day, for the public opinion on this subject.

That this subject gave rise to as much nonsense as ever was written, need scarcely be told ; while the greater the difficulty which we imagined we found in coping with them in this field, the greater was our anger. These politicians forgot that Holland was overflowing with capital and industry, and was driven to this occupation for want of other employment for its people, as of vent for its capital. They forgot also that the industry and capital of Great Britain were much more profitably, as well as more agreeably, occupied ; and that neither force, nor bad writing, nor bounties, nor acts of parliament, would succeed in diverting either from a profitable trade to a bad one, or from occupations of little labour to one extremely laborious and disagreeable. Yet thus were passed the chief Acts of Parliament in Charles the Second's time, particularly after 1672 ; when it is palpable that they were

also as much dictated by a spirit of jealousy, as the desire of gain.

Pursuing the same system, the bounties were established in 1748, and as the quantity or rate of these fluctuated, the herring fishery rose and again declined. It was at a low ebb during the American war, as well as during the last. Nor could any reasonable bounty have enticed capital into it under those states of commerce; though our politicians did not even then appear to have reflected that there was no capital to spare for such an employment, that there were abundant and much more enticing demands on it from other quarters, and that the trade itself had the further demerit of being new, precarious, and disagreeable. This was the true cause of the declension of the herring fishery; and were the same causes to be renewed, it would decline again. If it is now flourishing, it is chiefly from the superabundance of capital, and from the want of better outlets to our industry. England will have cause to lament the day which shall render her the great herring fisher; the rival of the ancient Dutch, and the envy of politicians of the same caliber as Aaron Hill and Oliver Goldsmith.

The raising of the barrel bounty to four shillings in 1815, and the admission of rock salt in 1817, were the last regulations, and those under which this trade is now flourishing. These are all, at least that I shall notice, as I cannot here afford to trace the whole history of the fishing regulations, since they would in themselves make a volume. The chief of the others, however, which do require notice, was the Act for the minimum of the meshes, (a very questionable policy as it regards the domestic fishery,) and the method of gutting and bleeding the fish, as practised by the Dutch. Under this process, where carefully followed, the Scottish herrings are now found to be equal to the Dutch, and to compete with them in the foreign market. The bounty regulation is a very doubtful benefit. It is costly without being necessary; and amongst the fishermen in general, the restrictions and trouble which attend the various regulations, are so great as to make it a very common wish that it should be rescinded, and the whole trade left free. It is argued, on the other hand, that, without force, the fishermen and

merchants will make and sell bad fish; to which the obvious answer is this, this would be against their interests, as they would soon have no buyers.

But to pass from this. There has been, under these various circumstances, a progressive increase in the quantity taken; while from 1816 to 1820, beyond which this sketch does not extend, the quantity cured according to the regulations, and therefore entitled to the full bounty, has also progressively increased. But there is another important cause here implicated. The great increase has not arisen from the extension of the Buss, or deep sea fishery, but from that of the boat fishery. This is carried on by the small farmers and fishermen who reside on the sea-shores, who sell to the busses, which thus find it a more profitable trade to buy from them than to fish for themselves. Thus far our fishery differs from that of the Dutch, which was carried on by large sloops or herring busses in the deep sea. Thus the main cause of the increase is not to be sought in the acts of parliament and regulations only, nor exclusively in the superabundance of capital. It has been one chief result of the alterations in the system of Highland farming, by which, in consequence of the allotment of the interior tracts to sheep, the people have migrated to the sea-shores as occupiers of fishing crofts. While this mode of fishing has been found the most profitable, in a commercial view, it has also produced the advantage of finding employment for the formerly unoccupied people of the Highlands, and has been, in fact, one of the great but overlooked benefits, which has flowed from a system against which such a senseless and protracted clamour has been raised.

It is, perhaps, time to reflect whether bounties can any longer be necessary. The solution of this question must be sought in the preceding facts. Circumstances have changed. Capital is now seeking employment. So is Highland industry; so is industry in general. If the bounties force a larger fishery than finds a vent, they are no longer beneficial; they cannot at least be necessary. But I need not dwell on this part of the present subject. I shall, therefore, pass over all that relates to the present legislative regulations, whether as these relate to salt, or to any thing else, for the

purpose of offering a few remarks on the singular state of the market.

If we take the year 1820 as a standard, the herring fishery has not only arrived at its maximum, but has exceeded that, and must be reduced. It has, once at least, exceeded the demand, as I shall presently show. Now as the supply appears inexhaustible, and as the demand for food appears equally so, it is an object of curiosity to inquire what it is which has thus brought it to a state of rest; a state of rest which would at least seem to render all further encouragement unnecessary. This is true of other fisheries. The Ling fishery of Shetland is in the same state, restricted by an insufficient demand. If it is inquired why they do not fish more, the fishermen answer briefly, "the people will eat no more salt fish." Thus they account for that limited demand which checks their industry, and which also, as in all similar cases of limited and doubtful demand, generally keeps the supply down to a state somewhat lower than that which would really find a sale. This must be recollected, in examining this question; for however a greater or an occasionally higher sale might occur, it is the business of the producer, for his own interest, first to take care that there is really a demand, and then to watch that his supply shall not exceed it. It is the object of the merchant to see that demand both precedes and exceeds supply.

It appears very difficult, practically, to admit the theory of the fishermen as it relates to the consumption of salt fish. As to the West India demand for herrings, that can be accurately calculated, because it is compulsory on the consumers. The Spanish demand for ling is equally certain and regular; because it is also compulsory from other causes, and because there is no great fluctuation in the number of consumers. In neither case is it a matter of taste or opinion, and it is therefore subject to no caprices. But that the people of Britain who are often in want of animal food, those of Ireland and Scotland in particular scarcely ever seeing it, should refuse to eat salt fish, is hardly credible. They assuredly show no dislike to it on the sea-coasts where they have ready access to it; and in most maritime districts indeed, it forms a princi-

pal part of their diet. It is not to be supposed that the labourer of the interior would not eat herrings rather than be confined all the year to oatmeal, potatoes, or bread ; and if there is no fish consumed in these districts, it must be from want of knowledge, want of habit, or from defect of the internal commercial arrangements of the county.

That it would be highly advantageous, both to the people themselves and to the merchants and fishermen, to diffuse that habit and that knowledge, can admit of no doubt ; as it is folly to say that salt fish is not a nutritious diet. That this has been neglected, is equally apparent ; and it seems particularly to have been neglected by our monstrous charitable establishments, in whose department it would seem particularly to lie. If it were possible to excite such a demand, and that a steady one, our fisheries would prosper in proportion, and can now prosper in no other way, as they have overstocked the foreign market ; that market which cannot be extended as the home one may. But as long as the fishermen are checked by their frequent losses on a perishable commodity of precarious sale, they must restrict or withdraw. To excite such a fashion or demand, would be an act worth all bounties that ever were invented. The true object of policy is not to produce the article, but to produce a sale for it.

If we reflect on our peculiarly maritime situation, the inexhaustible supply which our seas afford, and the constant occupation for industry here found, it has been a singularly unfortunate circumstance, that those who framed the model of our Reformed Church did not retain at least the weekly fast. It is a misfortune that they had not been persons of more general views, and economists. Much was retained that was matter of indifference on the great points at issue ; for the sole purpose of drawing a line short of the extremity of reform. Had this also been retained, a point in itself indifferent, the beneficial consequences would have been very great ; as it would not only have operated by its direct effects, but have tended to diffuse the general commerce of fish in the interior of our own country, and the general habit of consuming it. It is easy to conjecture how advantageously it would have

operated, when, even now, we derive so much benefit from the fasts of the foreign Catholic church as the ground of a branch of commerce.

But I must conclude this sketch of a subject which might easily be extended to an inconvenient length, and shall subjoin some documents from the official reports and profits and illustrations of some of the preceding views and arguments. They will shew among other things, the state of the market and the supply, and the comparative produce of the east and west coasts of Scotland. The period I have selected is one of five years, as I cannot, without trespassing on the prescribed bounds, take a larger one.

In 1815, there were about 160,000 barrels cured; and in 1816, this had increased to 163,000 only. In 1817, the increase was to 192,000; and in 1818, it took a sudden start, and was 228,000. In 1819, it had advanced to 326,000 on the east coast, and we here trace distinctly its gradual increase and parallel course, to the various causes I have already laid down. The increase in 1820 had advanced, even on 1819; but though I have lost this document, the consequences were such as to have left a considerable quantity on hand unsaleable, producing a very serious loss to the merchants.

As to the east and west coasts, in 1819, the proportion was about 81,600 for the latter, that of the former being, as already stated, 326,000; but as the boats of Glasgow, Grenock, and Rothesay, stand for about 53,000 of the latter, and as they buy on the east as well as the west coasts, it is estimated that the eastern was to the western fishery as 280 to 45 nearly. Formerly, the eastern fishery was limited to Wick, which also furnished 21,000 of the produce of 1819. The remainder is, in a great measure, to be attributed to the improvements upon the Sutherland estate.

I must now remark, that the average weight of the herring cask is between 120 and 130 pounds, and that the number of fish averages 800. Now the exportation of white herrings in 1819, was about 227,000 barrels; leaving about 108,500, or eighty-seven millions of fish, for home consumption, exclusive of the comparatively small quantity produced by England and the Isle of

Man. If we take the nearest round numbers, and allow only two herrings a day for an adult, this would be an annual supply of a proportion of animal food for little more than 119,000 individuals. But this quantity would scarcely be a sufficient supply of food for 40,000 persons, allowing six fish a day. It is hardly necessary to remark how trifling a supply this is for the home consumption, in an article of which the production seems to be illimitable. It is plain that much may yet be done towards increasing the food of the people, when the habit shall have been excited, and the circulation of this article better understood. The price is not the obstacle, because the price of 800 fish was only twenty shillings. Animal food could not well be cheaper than when nearly two herrings could be procured for a halfpenny, or when an adult could be completely fed for three halfpence a day. That, with such a price and such possibilities, the poor of this country should have wanted animal food in 1819, when the market was glutted to the ruin of the proprietors, is not one of the least curious facts in a science which has for some time abounded, even to weariness, in theoretical writers.

J. MAC CULLOCH.

ART. IV. *A new Demonstration of Taylor's Theorem.* By
Edward Wilmot, Esq., T.C.D.

[To the Editor of the QUARTERLY JOURNAL.]

Sir,

September 16, 1823.

THOSE who are in the habit of lecturing in the elementary parts of mathematics, must frequently feel the difficulty of making the common proofs of *Taylor's Theorem* for the development of functions intelligible to the junior students. This difficulty I have myself frequently felt, and I know it is complained of by the professors in the French colleges. I am, therefore, induced to send you a demonstration which appears to me at once simple and valid. It is independent of those assumptions in functional principles which are involved in the proofs, and which, though they are perfectly clear to the expert and practised analyst, are always embarrassing, and often absolutely unintelligible, to the beginner. The proof which

I annex was given me at one of my lectures in our University by an undergraduate, whose knowledge of the calculus was limited to the first twenty sections of Lacroix. It is independent of the theorem of Maclaurin, and gives that series as a particular case. In this respect, amongst others, it excels the proofs of Lacroix.

I am Sir, &c.

DIONYSIUS LARDNER, A.M.

University of Dublin.

Demonstration of Taylor's Theorem, by Edward Wilmot, Esq.
Trinity College, Dublin.

Let $n = F(x)$ and $n' = F(x + h)$; let

$$n' = A + B(x+h) + C(x+h)^2 + D(x+h)^3 + E(x+h)^4 + \dots$$

Where $A, B, C, \dots$ are independent of x and h . The powers of $(x + h)$ being expanded, and the series disposed by the dimensions of h , it becomes

$$n' = (A + Bx + Cx^2 \dots) + (B + 2Cx + 3Dx^2 \dots)h + (C + 3Dx + 6Ex^2 \dots)h^2 + \dots$$

The successive co-efficients of this series are evidently

$$n, \frac{dn}{dx}, \frac{d^2n}{dx^2}, \frac{1}{1.2}, \frac{d^3n}{dx^3}, \frac{1}{1.2.3}, \frac{d^4n}{dx^4}, \frac{1}{1.2.3.4}, \dots$$

Hence we have

$$n' = n + \frac{dn}{dx} \cdot \frac{h}{1} + \frac{d^2n}{dx^2} \cdot \frac{h^2}{1.2} + \frac{d^3n}{dx^3} \cdot \frac{h^3}{1.2.3} + \dots$$

By supposing $x = 0$ in this series, we find that of Maclaurin.

ART. V. *Historical Statement respecting the Liquefaction of Gases.* By Mr. M. Faraday, Cor. Mem. R. Acad. Paris, Chem. Assist. in the Royal Institution, &c.

I WAS not aware at the time when I first observed the liquefaction of chlorine gas*, nor until very lately, that any of the class of bodies called *gases*, had been reduced into the fluid form; but, having during the last few weeks sought for instances where such results might have been afforded without the knowledge of the

* *Phil. Transactions*, 1823, pp. 160.189.

experimenter, I was surprised to find several recorded cases. I have thought it right therefore to bring these cases together, and only justice to endeavour to secure for them a more general attention, than they appear as yet to have gained. I shall notice in chronological order, the fruitless, as well as the successful, attempts, and those which probably occurred without being observed, as well as those which were remarked and described as such.

Carbonic Acid, &c.—The *Philosophical Transactions* for 1797, contain, p. 222, an account of experiments made by Count Rumford, to determine the force of fired gunpowder. Dissatisfied both with the deductions drawn, and the means used previously, that philosopher proceeded to fire gunpowder in cylinders of a known diameter and capacity, and closed by a valve loaded with a weight that could be varied at pleasure. By making the vessel strong enough and the weight sufficiently heavy, he succeeded in confining the products within the space previously occupied by the powder. The Count's object induced him to vary the quantity of gunpowder in different experiments, and to estimate the force exerted only at the moment of ignition, when it was at its maximum. This force which he found to be prodigious, he attributes to aqueous vapour intensely heated, and makes no reference to the force of the gaseous bodies evolved. Without considering the phenomena which it is the Count's object to investigate, it may be remarked, that in many of the experiments made by him, some of the gases, and especially carbonic acid gas, were probably reduced to the liquid state. The Count says,

“ When the force of the generated elastic vapour was sufficient to raise the weight, the explosion was attended by a very sharp and surprisingly loud report ; but when the weight was not raised, as also when it was only a little moved, but not sufficiently to permit the leather stopper to be driven quite out of the bore, and the elastic fluid to make its escape, the report was scarcely audible at the distance of a few paces, and did not at all resemble the report which commonly attends the explosion of gunpowder. It was more like the noise which attends the breaking of a small

glass tube, than any thing else to which it could be compared. In many of the experiments, in which the elastic vapour was confined, this feeble report attending the explosion of the powder, was immediately followed by another noise totally different from it, which appeared to be occasioned by the falling back of the weight upon the end of the barrel, after it had been a little raised, but not sufficiently to permit the leather stopper to be driven quite out of the bore. In some of these experiments a very small part only of the generated elastic fluid made its escape, in these cases the report was of a peculiar kind, and though perfectly audible at some considerable distance, yet not at all resembling the report of a musket. It was rather a very strong sudden hissing, than a clear distinct and sharp report."

In another place it is said, "What was very remarkable in all these experiments, in which the generated elastic vapour was completely confined, was the small degree of expansive force which this vapour appeared to possess, after it had been suffered to remain a few minutes, or even only a few seconds, confined in the barrel; for upon raising the weight, by means of its lever, and suffering this vapour to escape, instead of escaping with a loud report it rushed out with a hissing noise, hardly so loud or so sharp as the report of a common air-gun, and its effects against the leather stopper, by which it assisted in raising the weight, were so very feeble as not to be sensible." This the Count attributes to the formation of a hard mass, like a stone, within the cylinder, occasioned by the condensation of what was, at the moment of ignition, an elastic fluid. Such a substance was always found in these cases; but when the explosion raised the weight and blew out the stopper, nothing of this kind remained.

The effects here described both of elastic force and its cessation on cooling, may evidently be referred as much to carbonic acid and perhaps other gases as to water. The strong sudden hissing observed as occurring when only a little of the products escaped, may have been due to the passage of the gases into the air, with comparatively but little water, the circumstances being such as were not sufficient to confine the former, though they

might the latter; for it cannot be doubted but that in similar circumstances, the elastic force of carbonic acid would far surpass that of water. Count Rumford says, that the gunpowder made use of, when well shaken together, occupied rather less space than an equal weight of water. The quantity of residuum before referred to, left by a given weight of gunpowder, is not mentioned, so that the actual space occupied by the vapour of water, carbonic acid, &c., at the moment of ignition, cannot be inferred; there can, however, be but little doubt that when perfectly confined they were in the state of the substances, in M. Cagniard de la Tour's experiments*.

When allowed to remain a few minutes, or even seconds, the expansive force at first observed, diminished exceedingly, so as scarcely to surpass that of the air in a charged air-gun. Of course all that was due to the vaporization of water and some of the other products would cease, as soon as the mass of metal had absorbed the heat, and they would concrete into the hard substance found in the cylinder: but it does not seem too much to suppose, that so much carbonic acid was generated in the combustion, as would, if confined, on the cooling of the apparatus, have been equal to many atmospheres, but that being condensible, a part became liquid, and thus assisted in reducing the force within, to what it was found to be.

Ammonia.—I find the condensation of ammoniacal gas referred to in *Thomson's System*, first edition, i. 405, and other editions; *Henry's Chemistry*, i. 237; *Accum's Chemistry*, i. 310; *Murray's Chemistry*, ii. 73.; and *Thenard's Traité de Chimie*, ii. 133. Mr. Accum refers to the experiments of Fourcroy and Vauquelin, *Ann. de Chimie*, xxix. 289, but has mistaken their object. Those chemists used highly saturated solution of ammonia, see pp. 281, 286, and not the gas; and their experiments on gases, namely, sulphurous acid gas, muriatic acid gas, and sulphuretted hydrogen gas, they state were fruitless, p. 287. "All we can say is, that the condensation of most of these gases was above three fourths of their volume."

Thomson, Henry, Murray, and, I suppose, Thenard, refer to the

* See vol. xv. p. 145, of this Journal.

experiments of Guyton de Morveau, *Ann. de Chimie.* xxix. 291, 297. Thomson states the result of liquefaction at a temperature of -45° , without referring to the doubt, that Morveau himself raises, respecting the presence of water in the gas; but Murray, Henry, and Thenard, in their statements notice its probable presence. Morveau's experiment was made in the following manner: a glass retort was charged with the usual mixture of muriate of ammonia, and quick lime, the former material being sublimed, and the latter carefully made from white marble, so as to exclude water as much as possible. The beak of the retort was then adapted to an apparatus consisting of two balloons, and two flasks successively connected together, and luted by fat lute. The balloons were empty, the first flask contained mercury, the second, water. Heat was then applied to the retort, and the first globe cooled to -21.25°C. , aqueous vapours soon rose, which condensed as water in the neck of the retort, and as ice in the first balloon. Continuing the heat, ammoniacal gas was disengaged, and it escaped by the last flask containing water, without any thing being perceived in the second balloon. This balloon was then cooled to -43.25°C. , and then drops of a fluid lined its interior, and ultimately united at the bottom of the vessel. When the thermometer in the cooling mixture stood at -36.25°C. , the fluid already deposited preserved its state, but no further portions were added to it; reducing the temperature again to -41°C. , and hastening the disengagement of ammoniacal gas, the liquid in the second balloon augmented in volume. Very little gas escaped from the last flask, and the pressure inwards was such as to force the oil of the lute into the balloon where it congealed. Finally, the apparatus was left to regain the temperature of the atmosphere, and as it approached to it, the liquid of the second balloon became gaseous. The fluid in the first balloon became liquid, as soon as the temperature had reached -21.25°C.

M. Morveau remarks on this experiment, that it appears certain that ammoniacal gas made as dry as it can be, by passing into a vessel in which water would be frozen, and reduced to a temperature of -21°C. , condenses into a liquid at the temperature of -48°C. , and resumes its elastic form again as the temperature is raised;

but he proposes to repeat the experiment and examine whether a portion of the gas so dried, when received over mercury would not yield water to well calcined potash, "for as it is seen that water charged with a little of the gas, remained liquid in the first balloon, at a temperature of -21° ., it is possible that a much smaller quantity of water united to a much larger quantity of the gas, would become capable of resisting a temperature of -48°C ."

Sir H. Davy, who refers to this experiment in his *Elements of Chemical Philosophy*, p. 267, urges the uncertainty attending it, on the same grounds that Morveau himself had done; and now that the strength of the vapour of dry liquid ammonia is known, it cannot be doubted that M. Morveau had obtained in his second balloon only a very concentrated solution of ammonia in water. I find that the strength of the vapour of ammonia dried by potash, is equal to about that of 6.5 atmospheres at 50°F^* . and according to all analogy it would require a very intense degree of cold, and one at present beyond our means, to compensate this power and act as an equivalent to it.

Sulphurous Acid Gas.—It is said that sulphurous acid gas has been condensed into a fluid, by Monge and Clouet, but I have not been able to find the description of their process. It is referred to by Thomson, in his *System*, first edition, ii. 24; and in subsequent editions; by Henry, in his *Elements*, i. 341; by Accum, in his *Chemistry*, i. 319; by Aikin, *Chemical Dictionary*, ii. 391; by Nicholson, *Chemical Dictionary*, article, gas (Sulphurous acid); and by Murray, in his *System*, ii. 405. All these authors mention the simultaneous application of cold and pressure, but Thomson alone refers to any authority, and that is Fourcroy, ii. 74.

It is curious that Fourcroy does not, however, mention condensation as one of the means employed by Monge and Clouet, but merely says the gas is capable of liquefaction at 28° of cold. "This latter property," he adds, "discovered by citizens Monge and Clouet, and by which it is distinguished from all the other gases, appears to be owing to the water which it holds in solution, and to which it adheres so strongly as to prevent an accurate estimate of the proportions of its radical and acidifying principles."

* *Philosophical Transactions*, 1823, p. 197.

Notwithstanding Fourcroy's objection, there can be but little reason to doubt that Monge and Clouet did actually condense the gas, for I have since found that from the small elastic force of its vapour at common temperatures, (being equal to that of about two atmospheres only*) a comparatively moderate diminution of temperature is sufficient to retain it fluid at common pressure, or a moderate additional pressure to retain it so at common temperature; so that whether these philosophers applied cold only as Fourcroy mentions, or cold and pressure, as stated by the other chemists, they would succeed in obtaining it in the liquid form.

Chlorine.—M. de Morveau, whilst engaged on the application of the means best adapted to destroy putrid effluvia and contagious miasmata, was led to the introduction of chlorine as the one most excellent for this purpose; and he proposed the use of phials, containing the requisite materials, as sources of the substance. One described in his *Traité des Moyens de désinfecter l'air* (1801), was of the capacity of two cubical inches nearly; about 62 grains of black oxide of manganese in coarse powder was introduced, and then the bottle two-thirds filled with nitro-muriatic acid; it was shaken, and in a short time chlorine was abundantly disengaged. M. Morveau remarks upon the facility with which the chlorine is retained in these bottles; one, thus prepared, and forgotten, when opened at the end of eight years, gave an abundant odour of chlorine.

I had an impression on my mind that M. de Morveau had proposed the use of phials similarly charged, but made strong, well stoppered, and confined by a screw in a frame, so that no gas should escape, except when the screw and stopper were loosened; but I have searched for an account of such phials without being able to find any. If such have been made, it is very probable that in some circumstances, liquid chlorine has existed in them, for as its vapour at 60° F. has only a force of about four atmospheres†, a charge of materials might be expected frequently to yield much more chlorine than enough to fill the space, and saturate the fluid present; and the excess would of course take the liquid form. If such vessels have not been made, our present

* *Philosophical Transactions*, 1823, p. 192.

† *Ibid.* p. 198.

knowledge of the strength of the vapour of chlorine will enable us to construct them of a much more convenient and portable form than has yet been given to them.

Arseniuretted Hydrogen.—This is a gas which it is said has been condensed so long since as 1805. The experiment was made by Stromeyer, and was communicated, with many other results relating to the same gas, to the Gottingen Society, Oct. 12, 1805. See *Nicholson's Journal*, xix. 382; also, *Thenard Traité de Chimie*, i. 373; *Brande's Manual*, ii. 212; and *Annales de Chimie*, lxiv. 303. None of these contain the original experiment; but the following quotation is from *Nicholson's Journal*. The gas was obtained over the pneumatic apparatus, by digesting an alloy of fifteen parts tin and one part arsenic, in strong muriatic acid. "Though the arsenicated hydrogen gas retains its aëriform state under every known degree of atmospheric temperature and pressure, Professor Stromeyer condensed it so far as to reduce it in part to a liquid, by immersing it in a mixture of snow and muriate of lime, in which several pounds of quicksilver had been frozen in the course of a few minutes." From the circumstance of its being reduced only in part to a liquid, we may be led to suspect that it was rather the moisture of the gas that was condensed than the gas itself; a conjecture which is strengthened in my mind from finding that a pressure of three atmospheres was insufficient to liquefy the gas at a temperature of 0°F.

Chlorine.—The most remarkable and direct experiments I have yet met with in the course of my search after such as were connected with the condensation of gases into liquids, are a series made by Mr. Northmore, in the years 1805-6. It was expected by this gentleman "that the various affinities which take place among the gases under the common pressure of the atmosphere, would undergo considerable alteration by the influence of condensation;" and it was with this in view that the experiments were made and described. The results of liquefaction were therefore incidental, but at present it is only of them I wish to take notice. Mr. Northmore's papers may be found in *Nicholson's Journal*, xii. 368. xiii. 232. In the first is described his apparatus, namely, a brass condensing pump; pear-shaped glass re-

ceivers, containing from three and a half to five cubic inches, and a quarter of an inch thick; and occasionally a syphon gauge. Sometimes as many as eighteen atmospheres were supposed to have been compressed into the vessel, but it is added, that the quantity cannot be depended on, as the tendency to escape even by the side of the piston, rendered its confinement very difficult.

Now that we know the pressure of the vapour of chlorine, there can be no doubt that the following passage describes a true liquefaction of that gas. "Upon the compression of nearly two pints of oxygenated muriatic acid gas in a receiver, two and a quarter cubic inches capacity, it speedily became converted into a yellow *fluid*, of such extreme volatility, under the common pressure of the atmosphere, that it instantly evaporated upon opening the screw of the receiver; I need not add, that this fluid, so highly concentrated, is of a most insupportable pungency." "There was a trifling residue of a yellowish substance left after the evaporation, which probably arose from a small portion of the oil and grease used in the machine," &c. xiii. 235.

Muriatic Acid.—Operating upon muriatic acid, Mr. Northmore obtained such results as induced him to state he could liquify it in any quantity, but as the pressure of its vapour at 50° F. is equal to about 40 atmospheres*, he must have been mistaken. The following is his account: "I now proceeded to the muriatic acid gas, and upon the condensation of a small quantity of it, a beautiful green-coloured substance adhered to the side of the receiver, which had all the qualities of muriatic acid; but upon a large quantity, four pints, being condensed, the result was a yellowish green glutinous substance, which does not evaporate, but is instantly absorbed by a few drops of water; it is of a highly pungent quality, being the essence of muriatic acid. As this gas easily becomes fluid, there is little or no elasticity, so that any quantity may be condensed without danger. My method of collecting this and other gases, which are absorbable by water, is by means of an exhausted Florence flask, (and in some cases an empty bladder) connected by a stop cock with the extremity of the retort." xiii. 235. It seems probable that the facility of con-

* *Philosophical Transactions*, 1823, p. 198.

densation, and even combination, possessed by muriatic acid gas in contact with oil of turpentine, may belong to it under a little pressure, in contact with common oil, and thus have occasioned the results Mr. Northmore describes.

Sulphurous Acid Gas.—With regard to this gas, Mr. Northmore says, “having collected about a pint and a half of sulphurous acid gas, I proceeded to condense it in the three cubic inch receiver, but after a very few pumps the forcing piston became immoveable, being completely choked by the operation of the gas. A sufficient quantity had, however, been compressed to form vapour, and a thick slimy fluid, of a dark yellow colour, began to trickle down the sides of the receiver, which immediately evaporated with the most suffocating odour upon the removal of the pressure.”
 xiii 236. This experiment, Mr. Northmore remarks, corroborates the assertion of Monge and Clouet, that by cold and pressure they had condensed this gas. The fluid above described was evidently contaminated with oil, but from its evaporation on removing the pressure, and from the now ascertained low pressure of the vapour of sulphurous acid, there can be no hesitation in admitting that it was sulphurous acid liquefied.

The results obtained by Mr. Northmore, with chlorine gas and sulphurous acid gas, are referred to by Nicholson, in his *Chemical Dictionary*, 8vo. Articles, Gas (muriatic acid oxygenized) and Gas (sulphurous acid); and that of chlorine is referred to by Murray, in his *System*, ii. 550; although at page 405 of the same volume, he says that, only sulphurous acid “and ammonia of these gases that are at natural temperatures permanently elastic, have been found capable of this reduction.”

Carbonic Acid.—Another experiment in which it is very probable that liquid carbonic acid has been produced, is one made by Mr. Babbage, about the year 1813. The object Mr. Babbage had in view, was to ascertain whether pressure would prevent decomposition, and it was expected that either that would be the case, or that decomposition would go on, and the rock be split by the expansive force of carbonic acid gas. The place was Chudley rocks, Devonshire, where the limestone is dark and of a compact texture. A hole, about 30 inches deep and two inches in diameter,

was made by the workmen in the usual way, it penetrated directly downwards into the rock; a quantity of strong muriatic acid, equal to perhaps a pint and a half, was then poured in, and immediately a conical wooden plug, that had previously been soaked in tallow, was driven hard into the mouth of the hole. The persons about then retired to a distance to watch the result, but nothing apparent happened, and, after waiting some time, they left the place. The plug was not loosened at the time, nor was any further examination of the state of things made: but it is very probable that if the rock were sufficiently compact in that part, the plug tight, and the muriatic acid in sufficient quantity, that a part of the carbonic acid had condensed into a liquid, and thus, though it permitted the decomposition, prevented that development of power which Mr. Babbage expected would have torn the rock asunder.

Oil Gas Vapour.—An attempt has been made by Mr. Gordon, within the last few years, and is still continued, to introduce condensed gas into use in the construction of portable, elegant, and economical gas lamps. Oil gas has been made use of, and, I believe, as many as thirty atmospheres have been thrown into vessels, which, furnished with a stop cock and jet, have afterwards allowed of its gradual expansion and combustion. During the condensation of the gas in this manner, a liquid has been observed to deposit from it. It is not, however, a result of the liquefaction of the gas, but the deposition of a vapour (using the terms gas and vapour in their common acceptation) from it, and when taken out of the vessel it remains a liquid at common temperatures and pressures; may be purified by distillation, in the ordinary way, and will even bear a temperature of 170° F. before it boils, at ordinary pressure. It is the substance referred to by Dr. Henry, in the *Philosophical Transactions*, 1821. p. 159.

There is no reason for believing that oil gas, or olefiant gas, has, as yet, been condensed into a liquid, or that it will take that form at common temperatures under a pressure of five, or ten, or even twenty atmospheres. If it were possible, a small, safe, and portable gas lamp would immediately offer itself to us, which might

be filled with liquid without being subject to any greater force than the strength of its vapour, and would afford an abundant supply of gas as long as any of the liquid remained. Immediately upon the condensation of cyanogen, which takes place at 50° F. at a pressure under four atmospheres, I made such a lamp with it. It succeeded perfectly, but, of course, either the expense of the gas, the faint light of its flame, or its poisonous qualities, would preclude its application. But we may, perhaps, without being considered extravagant, be allowed to search in the products of oil, resins, coal, &c. distilled, or otherwise treated, with this object in view, for a substance, which being a gas at common temperatures and pressure, shall condense into a liquid, by a pressure of from two to six or eight atmospheres, and which being combustible, shall afford a lamp of the kind described*.

Atmospheric Air.—As my object is to draw attention to the results obtained in the liquefaction of gases before the date of those described in the *Philosophical Transactions* for 1823, I need not, perhaps, refer to the notice given in the *Annals of Philosophy*, N.S. vi. 66, of the supposed liquefaction of atmospheric air, by Mr. Perkins, under a pressure of about 1100 atmospheres, but as such a result would be highly interesting, and is the only additional one on the subject I am acquainted with, I am desirous of doing so, as well also to point out the remarkable difference between that result and those which are the subject of this and the other papers referred to. Mr. Perkins informed me that the air upon compression disappeared, and in its place was a small quantity of a fluid, which remained so when the pressure was removed, which had little or no taste, and which did not act on the skin. As far as I could by inquiry make out its nature, it resembled water, but if upon repetition it be found really to be the product of compressed common air, then its fixed nature shews it to be a result of a very different kind to those mentioned above, and necessarily attended by far more important consequences.

* In reference to the probability of such results, see a paper "On Olefiant Gas." *Annals of Philosophy*, N.S. iii. 37.

ART VI. Lamarck's *Genera of Shells*.

[Concluded from Vol. XVI. p. 79.]

4th Family.

SPHÆRULATA *. (3 genera.)

Shell globular, spheroidal, or oval; whorls of the spire enveloping, or the chambers united under one covering.

The sphærulata are small, spheroidal or oval, multilocular shells, some having no other cavity than those of the chambers, and their whorls enveloping one another; others are furnished with a peculiar internal cavity, and are composed of a series of elongated, narrow, contiguous chambers, arranged in a portion of a circle, which, by their union, form a single coat, that envelopes the central cavity.

1. *Milliolites* †.

Shell transverse, oval-globular, or elongated, multilocular; chambers transverse, surrounding the axis, and successively covering one another; aperture very small, situated at the base of the last whorl, orbicular, or oblong.

Lamarck states that he possesses some milliolites, (or rather *milliolitæ*,) in the recent state, which were found on fuci, near the Island of Corsica; but all the species he describes are fossil. In that state they occur in such vast abundance as to form the principal part of the stony masses of some of the quarries near Paris.

The size of these tiny shells scarcely exceeds that of grains of millet (whence their name); some are globular, inclining to oval, others oblong, or somewhat triangular. Their spire turns round an axis perpendicular to the plane of the whorls, and much longer than the transverse, or horizontal diameter of the shell; which is just the reverse of what takes place with the planorbes, ammonites, &c. The chambers, which are considerably broader than

* From *sphærule*, a little ball.† From *millium*, millet.

they are long, are transverse, envelope the whole length of the axis, and cover one another in succession, giving the shell a triangular form, three chambers being rather more than sufficient to complete a whorl.

Type. *Milliolites cor anguinum**.

Shell subcordate, inflated, duplex; aperture small, suborbicular. Fossil, Grignon. Pl. vi. Fig. 220. 4 Species †.

2. Melonites ‡.

Shell subspherical, multilocular; spire central; whorls contiguous, enveloping, tuniciform. Chambers narrow, elongated, and numerous; septa imperforate.

Type. *Melonites sphærica*§.

No further description. Pl. vi. Fig. 221. 2 Species.

5th Family.

RADIOLATA ||. (3 genera.)

Shell discoidal, spire central; chambers elongated, radiating from the centre to the circumference.

From the character of the shells of this family, it follows that their spire can have but one turn, and is consequently false, or imperfect.

1. Rotalites ¶.

Shell orbicular, spiral, convex or conoidal at the upper part; flattened, radiating, and tubercular, at the lower; multilocular. Radii wavy. Aperture marginal, triangular, inclined towards the base.

The rotalites are very small shells, widest at the base, with the whorls contiguous and distinct. The transverse septa which di-

* Serpent's heart.

† We omit the genus *gyrogonites*, altogether, on the authority of M.M. Cuvier and Brogniart, quoted below. The truth of Leman's observation, has since been confirmed by Mr. Sowerby. The passage alluded to will be found at page 61, of the *Description Géologique des Environs de Paris*. Speaking of the fossil shells of the third fresh-water formation, Messrs. B. and C. add, "There are also found in it those small, round, channelled bodies, which M. de Lamarck has named *gyrogonites*, and which, according to M. Leman's observations, appear to be the seed of a species of *chara*."

‡ From *melo*, a melon.

§ Spherical.

|| From *radius*, a ray.

¶ From *rota*, a wheel.

vide the chambers, radiate from the centre or axis of the shell towards the circumference, so that the chambers are slightly conical.

One species. *Rotalites trochidiformis**.

Shell conoidal; whorls carinate; lower side granular. Fossil, Grignon. Pl. vi. Fig. 222.

Lenticulites†.

Shell sublenticular, spiral, multilocular; exterior margin of the whorls triplicate, extending over the interior whorls, both above and below, to the centre of the shell. Septa entire, curved, produced on both sides like radii. Aperture narrow, projecting over the penultimate whorl.

The lenticulites are distinguished from the rotalites and discorbites, by the lateral prolongation of the chambers and septa, and from the nautilus, by not having the siphon of that shell. They are very similar in structure to the nummulites, but they differ from them by the prolongation of the chambers, &c., and by the projection of the aperture over the penultimate whorl. They are chiefly found in the fossil state, but Lamarck tells us that he possesses some recent species of this genus, which were found in the sea near Teneriffe, at the depth of 125 feet. He describes only three fossil species, but adds in a note, that the *nautilus calcar*, and *nautilus crispus*, of Gmelin, as well as the *nautilus calcar* of Fichtel, appear to be distinct species of lenticulinæ, and must be added to those he has described.

Type. *Lenticulites rotulata*‡.

Shell orbicular; margin acute; discs somewhat gibbous on both sides. Fossil, Meudon. Pl. vi. Fig. 223.

3. Placentula§.

Shell orbicular, discoidal, convex above and below, multilocular; aperture oblong, narrow, lying like the radius of a circle on the lower disc, or on both discs.

The placentulæ are divided internally into several chambers,

* *Trochus*-shaped.

† *Lenticula*, a little lentil.

‡ From *rotula*, a little wheel.

§ A little cake.

each extending from the centre to the circumference. Their aperture is the chief character which distinguishes them from the lenticulites.

Type. *Placentula pulvinata* *.

No further description. Pl. vi. Fig. 224. 2 Species, both recent.

6th Family.

NAUTILACEA. (6 genera.)

Shell discoidal, spire central, chambers short, not extending from the centre to the circumference.

The nautilacea differ widely from the radiolata, in having the spire composed of several whorls, wherefore the chambers cannot extend from the centre to the circumference: their spire is also complete, which that of the radiolata never is.

1. Discorbites †.

Shell discoidal, spiral, multilocular; sides simple. All the whorls visible, naked, contiguous to one another. Septa transverse, frequent, imperforate.

The discorbites differ from the nautili, by having all the whorls of the spire visible, and no siphon: from rostralites, by the aperture not inclining downwards towards the base, and the spire not rising into a cone.

One species. *Discorbites vesicularis* ‡.

Shell discoidal; whorls nodular at the chambers, subvesicular; last chamber somewhat closed. Fossil, Grignon. Pl. vi. Fig. 225.

Note, by Lamarck. The *Cornu ammonis vulgatissimum* of Plancus, (de Conch. Arimin. p. 8. t. 1. f. 1.) must be referred to this genus.

2. Siderolites

Shell multilocular, discoidal; whorls contiguous, not visible externally; disc convex on both sides, and loaded with tubercular points; circumference bordered with unequal radiating lobes. Septa transverse, imperforate. Aperture distinct, sublateral.

The siderolites are very small, star-shaped shells, with a sub-

* Made like a cushion, or pillow.

‡ Vesicular.

† From *discus*, a disk, and *orbis*, an orb.

§ From *sidus*, a star.

granular disc, and the circumference beset with several unequal points, diverging like radii.

One species. *Siderolites calcitrapoides**.

A small shell, very remarkable for its star-shape; it is subpapillous, with unequal projecting radii, with blunt points. Fossil, Maëstricht. Pl. vi. Fig. 226.

3. *Polystomella*†.

Shell discoidal, multilocular; whorls contiguous, not visible externally; their surface radiated by transverse furrows or ribs. Aperture composed of several foramina, variously disposed.

The polystomellæ are radiated externally by the projection of the transverse septa of the chambers, which extend from the summit to the circumference of the shell, crossing the whorls, which are not visible on the outside. These characters are common also to the lenticulites, but the aperture of the latter is simple, whilst that of the polystomella is composed of several holes, differently disposed in the different species.

Type. *Polystomella crispa*‡.

No further description. Pl. vi. Fig. 227. 4 Species, all recent.

4. *Vorticialis*§.

Shell discoidal, spiral, multilocular; whorls contiguous, not visible externally; septa transverse, imperforate, not extending from the centre to the circumference. Aperture marginal.

The vorticiales differ from the nummulites chiefly by having a distinct aperture, and from the discorbites, by the spiral whorls not being visible externally. Their axis is central, and confounded with the summit of the spire.

Type. *Vorticialis craticulata*¶.

No further description. Pl. vi. Fig. 228.

5. *Nummulites*||.

Shell lenticular, attenuated towards the edges; spire internal, discoidal, multilocular, covered with several thin plates; exterior

* Like the rowel of a spur.

‡ Curled.

¶ From *craticula*, a gridiron?

† From *πολυς*, many, and *στομα*, a mouth

§ From *vortex*, a whirlpool?

|| From *nummus*, a small coin.

side of the whorls triplicate, extending from both sides to the centre of the shell, and uniting. Chambers very numerous, small, alternate; septa imperforate, transverse.

The nummulites, by a transverse section in the direction of their plane, present from eighteen to twenty-four very narrow whorls, which seem to turn circularly round a central point, yet, nevertheless, describe a true spiral line, terminating in the last whorl; and since each of them is doubly folded at its exterior margin, they form as many little plates, above and below, as there are whorls, which all unite at the two centres. Now, between all these little plates, each whorl of the spiral is divided into a multitude of small chambers, formed by transverse, imperforate septa, extending rather obliquely towards the centre of each disc, losing themselves and disappearing between the plates, as they approach each other. Hence the shell is thickest in the middle.

Breyn, in 1732, and *Jean Gesner*, in 1758, conceived the idea that the nummulites are true univalve shells, very analogous to the ammonites, and Bruguières has since adopted their opinion, of the accuracy of which there can now be little question. They are very common fossils, and extremely abundant in various countries, often forming large stony masses. Bruguières considers them to be sea shells.

Type. *Nummulites lævigata**.

Shell lenticular, smooth, slightly convex on both sides.

Fossil, Villers-Coterets. Pl. vi. Fig. 229. 4 Species, all fossil.

6. Nautilus †.

Shell discoidal, spiral, multilocular; parietes simple, without any suture. Whorls contiguous; the last enveloping the others. Chambers numerous, narrow, transverse, formed by transverse septa; last chamber very large; septa concave on the side next to the aperture, their discs perforated by a tube, and their margins very simple.

The nautilus is generally rather a large shell, whose spire turns orbicularly in the same plane, round the central summit. A por-

* Smooth.

† The original name, from *nauta*, a sailor.

tion of the last whorl seems to be enveloped by the posterior part of the sack or mantle of the cephalopodous animal to which it belongs, the remainder of the shell being uncovered and visible; whilst another part of the animal is contained in the last chamber of the shell, to which it probably adheres by a tendinous ligament, inserted in the extremity of the siphon*. The want of colour at the end of the last whorl, confirms this supposition.

Type. *Nautilus pompilius*†. (Idem. Linn.)

Shell suborbicular, marked with red streaks; whorls smooth at the back and sides; aperture oblong-cordate; umbilicus concealed. *Indian Ocean.* Pl. vi. Fig. 230. 2 Species, both recent.

7th Family.

AMMONEATA. (5 genera.)

Septa sinuous, lobed and indented at the circumference, united at the inner surface of the shell, and articulating with it by means of indented sutures.

The multilocular shells of this family are very remarkable for the character of their septa, whose wavy and sinuous discs, lobed and indented at their circumference, form, by their union, as they fold back at their junction with the inner surface of the shell, a sort of indented sutures, not unlike the leaves of the parsley. These suture sare hidden by the exterior portion of the shell; but, although we usually find the ammoniata in the fossil state, after the shell has disappeared, still their casts display, in a very evident manner, the peculiar characters of the family.

Of the animals belonging to these shells we know nothing; but from their being multilocular, we presume, with great probability, that they are cephalopoda, and analogous to the nautili, though at the same time very distinct from that genus. It seems probable that the shell is wholly internal, and, as Bruguières has supposed, that most of them live at great depths in the ocean.

The general form of these multilocular shells varies extremely

* A similar confirmation, there is every reason to suppose, must belong to the ammonites, nummulites, &c. See what has been already said on this subject under the head *Spirula*.

† From *πομπιλος*, whence *pompilus*, a term used by Pliny, for a species of nautilus.

in the different genera. Some are discoidal, with spiral whorls either visible or enveloping; some form a turritid, pyramidal spire; whilst others are straight, or nearly so, without any spire at all.

1. Ammonites*.

Shell discoidal, spiral, whorls contiguous, and all of them visible; the interior parietes articulated by sinuous sutures. Septa transverse, lobed and indented at the circumference; their discs without any siphon, but perforated by a sort of marginal tube.

The ammonites differ essentially from the nautili, by the sinuous sutures of the internal parietes, and by the similarly sinuous form of the septa. From the orbulites, by all the whorls being distinctly visible.

The ammonites are only known in the fossil state, and most of the specimens, found in our collections, are merely internal pyritic casts of the shells. They are common in almost all countries, chiefly in schistose or argillaceous formations, and M. Ménard found one in the maritime Alps, at an elevation exceeding 9000 feet. Several species are of very large size. They abound so much in Burgundy, that the road between Auxerre and Avalon is mended with ammonites.

Type. *Ammonites Königi*†.

Shell discoid, convex, with radiating undulations; inner whorls half exposed; marginal undulations numerous; central undulations few, very prominent; aperture cordate elongated. Pl. vi. Fig. 231. From Kelloways‡.

2. Orbulites§.

Shell subdiscoidal, spiral, whorls contiguous, the last envelop-

* From *ammon*, a name of Jupiter, who was worshipped in Libya under the form of a ram. The old name of the ammonites was *cornu ammonis*, from their resemblance to a ram's horn.

† Named in honour of Mr. König.

‡ Our figure, and the preceding specific character, is taken from the Mineral Conchology of the late James Sowerby, Esq., in whose lamented death natural history has recently experienced a severe loss. The talents and ardour of his sons, happily forbid our deploring it as irreparable.

Lamarck describes 20 species of ammonites, but he has not given a single reference to any other author, or to any figure, for either of the species described.

§ From *orbis*, an orb.

ing the rest; internal parietes articulated by sinuous sutures. Septa transverse, lobed at the circumference, and perforated by a marginal tube.

Type. *Orbulites subradiatus**. (Ammonites subradiatus. Sowerby.)

Shell lenticular, umbilicated, carinated and radiated; radii twice curved, obscure, excepting near the margin, where they are bifid; umbilicus small; keel entire; aperture sagittate.

From a mass of olite, found on the road between Bath and Bristol. Pl. vi. Fig. 232.

3. Ammonoceratites†.

Shell corniform, arched, subsemicircular; parietes articulated by sinuous, ramose, indented sutures. Septa transverse, sinuous, lobed and indented at the circumference. Tube or siphon marginal, not perforating the septa.

The ammonoceratites seem to be to the multilocular shells with indented septa, what the spirula is to those with simple septa. In either case the whorls of the spire are not contiguous, and the present genus appears not even to form one complete whorl. The upper extremity is flattened at the sides, so as to become linguiform.

Type. *Ammonoceratites glossoidea*‡.

Shell very large, thick, cylindrical, arched, rather flat at the sides, inner side somewhat concave; apex compressed, linguiform. Said to be found in India. Pl. vi. Fig. 233.

* *Subradiated*. Our figure is from a specimen lent us by our kind friend Mr. G. B. Sowerby, and which has been drawn and described in the 5th vol. of the Mineral Conchology. Lamarck has described five species of orbulites, but given no reference to any figure of either of them, except to a doubtful one of the third, *O. striata*. We have adopted Mr. Sowerby's specific name and description of the specimen we have figured, which does not belong to either of the five species mentioned by Lamarck.

† From *Ἀμμων*, ammon, and *κερας*, a horn.

‡ From *γλωσσα*, a tongue, and *ειδος*, form. Our figure is copied from that in Bowdich's Elements of Conchology, who calls it *A. Lamarckii*, and says, in a note, "The locality is unknown. M. Lamarck purchased it by accident: he kindly allowed me to take it home, in order that the figure, which is the first that has been made, might be as accurate as possible." Part I. p. 21.

The shell has been broken in three pieces, as shewn in the figure. Its length is 19 inches, 2 lines. (*French measure.*) 2 Species.)

4. Turrilites *.

Shell spiral, turrited, multilocular, whorls contiguous, all visible; parietes articulated by sinuous sutures. Septa transverse, lobed and indented at the circumference. Aperture rounded.

The turrilites, instead of being discoidal, or simply arched, are elongated, straight, and form a very elevated spiral, which, it seems, must terminate in a point, like the turritella. Fragments of internal casts of this shell have been long known by the name of *turbinites*. We are indebted for a more accurate knowledge of the genus to M. Denis Montfort.

One species. *Turrilites costutala* †.

Shell straight, turrited; whorls convex, transversely ribbed; ribs tubercular at the extremities. *St. Catherine's Hill, near Rouen.* Pl. vi. Fig. 234.

5. Baculites ‡.

Shell straight, cylindrical, sometimes slightly compressed, rather conical; parietes articulated by sinuous sutures. Septa transverse, near together; disc of the septa imperforate, lobed and indented at the circumference.

The chambers of these shells, of which we have only the internal casts, are narrow, transverse, and differ in that respect from those of the turrilites, which are rather longitudinal, the septa which form them being farther asunder. In both, the chambers are filled with a matter.

Type *Baculites Faujasii* §.

Shell straight, cylindrical, slightly depressed at the opposite sides; sutures lobed, indented. *St. Peter's Mount, near Maëstricht.* Pl. vi. Fig. 235. 3 Species.

SECTION II.

Monothalamous Cephalopoda. (1 Genus.)

Shell unilocular, wholly external, and enveloping the animal.

* From *turris*, a tower.

† Ribbed.

‡ From *baculum*, a staff.

§ In honour of M. Faujas.

It is a very extraordinary circumstance that an animal, whose body is not in the slightest degree spiral, should form a spiral shell. The fact, however, is well ascertained, as the animal has been seen in its shell, and Lamarck states that he has seen it so himself. The curvature of the shell arises, he thinks, from the way in which the animal folds and rolls up some of its arms, when at rest within it. In the cephalopoda of the first section the portion of the body of the animal, enclosed by the shells, is contained in the last chamber; in this, the whole animal is enveloped by the shell.

The shell of the monothalamous cephalopoda is univalve, unilocular, wholly external, and capable of floating on the surface of the water. It is thin, fragile, and seems to have some analogy with that of the carinaria; but the animal, to which that shell belongs, is not a cephalopoda.

One genus. *Argonauta* *.

Shell univalve, unilocular, involute, very thin; spire bicarinated, turning into the aperture; carinæ tubercular.

The animal of the argonauta has a fleshy body, like the octopus, obtuse below, and principally contained in a non-alated sac, formed by the mantle. The head is furnished with lateral eyes, and terminated by the mouth, around which are ranged, like radii, eight elongated pointed arms, furnished with suckers. Two of these arms have, for two-thirds of their length, a thin, oval membrane, which the animal extends and contracts at pleasure.

The difference between this animal and the octopus, consists principally in the singular membrane just mentioned, and in the latter having no shell.

The argonauta does not appear to be attached to its shell, and it is said that it quits it when it pleases. It is asserted, moreover, that when it wishes to sail on the surface, it displaces the water from the shell, in order to lighten it, extends the two membranous arms, which serve as sails, and plunging the others in the sea, they perform the office of oars. If bad weather, or an enemy approach,

* From *argo*, the name of the ship which carried Jason from Thessaly to Colchis, and *nauta*, a sailor. Lamarck observes, that the genus *Argo*, of Leach, ought, perhaps, to be included in this section.

in an instant all is taken in; the animal ships his oars, strikes his sails, and upsets his boat, which fills with water and goes down: but when the danger is past, he returns to the surface, bends his sails again, and once more rows gallantly along.

“ The tender nautilus, who steers his prow,
The sea-born sailor of his shell canoe,
The ocean Mab, the fairy of the sea,—

* * * * *

He when the lightning-winged tornadoes sweep

The surge, is safe—his port is in the deep. BYRON.

Recent observations have vindicated the character of this clever little sailor from the aspersions heretofore cast on it, of being a mere pirate, who having killed and devoured the former inhabitant, seizes on his vessel: they have proved that he is lawful owner, and his own industrious shipwright—and beautiful is the model which his little frail bark is constructed! It somewhat resemble a nautilus in its external form, whence its trivial name, *paper nautilus*; but it is essentially different from that shell, in being unilocular. It is, besides, very thin, externally rugose or tubercular, and furnished with a double keel. The end of the spire always turns inwards and enters the cavity, and the last whorl envelopes all the others. The argonautæ are found in the Mediterranean, and East Indies.

Type. *Argonauta argo*. (Idem. *Linn.*)

Shell large, involute, very thin, white; sides transversely ribbed; ribs frequent, forked on one side; carinæ approximate, tubercular, partially blackish red; tubercles small, very numerous. *Mediterranean*. Pl. vi. Fig. 236. 3 Species, all recent.

SECTION III.

Naked Cephalopoda. (1 Family.)

The animals of this section have no shell, either internal or external, but the greater number of them contain a solid, free, cretaceous or horny substance in the interior of their body.

Sepiaria. (4 Genera.)

This family includes all the animals which Linneus comprehended under one generic name, *sepia*; they are the most perfectly known of all the cephalopodous mollusca.

The sepiaria are marine animals, none of them have any true shell, they always live in the sea, some crawling at the bottom, as the octopus, others, as the sepia and loligo, swimming freely in mid water, by means of the membranes or fins with which their sac is furnished.

The body of these animals is fleshy, half enclosed in a muscular sac, from which the head and anterior part of the body project. The head is crowned with tentacular arms, disposed like radii round the mouth, with suckers on the inner side. The branchiæ are enclosed in, and concealed by, the sac, on the outside of the peritoneum which contains the viscera. They are two in number, of a pyramidal form, and are situated one on each side of the peritoneum. The containing cavity has an external communication by the funnel under the neck, at the mouth of the sac, and which conveys the water to and from the branchiæ.

1. Octopus*.

2. Lorigopsis.

The second of these genera is wholly unprovided with any solid cretaceous or horny substance in the interior of its body, but the octopus has two cartilages inserted in the substance of the purse, or elongated sac, which partly contains the body. Cuvier describes these cartilages as having the form of a dagger, (*stilets*,) and says that they occupy the lower half of each side of the back, and are the only appearance of any thing resembling the sword of the calmar, (*Loligo*,) or the bone of the sepia. *Hist. et Anatom. des Mollusques*, p. 12.

The general form of the octopus is very analogous to that of the sepia and loligo; it has eight long, nearly equal arms, surrounding the mouth; no membranes for swimming attached to the sac, and the suckers are simply fleshy, and not provided with the horny indented ring, which constitutes the claw of the latter animals. They are the largest of the sepiaria. The lorigopsis has eight sessile and equal arms, round the mouth; two fins, or membranes, for swimming, attached to the lower part of the sac, and is of

* From *οκτώ*, eight, and *πῆς*, a foot.

small size. Only one species, *Loligopsis Peronii*, is known. Of the octopus, Lamarck describes four species.

3. *Loligo* *.

Body fleshy, contained in an elongated cylindrical sac; sac pointed at the base, and alate at the lower part. An elongated, thin, transparent, horny lamina, enclosed in the interior of the body, near the back. Mouth terminal, furnished with strong horny mandibles, like a parrot's bill, and surrounded by ten arms; arms furnished with suckers, with circular, cartilaginous rings, with simple edges; two of the arms longer than the rest, and pedunculated.

The loligo is distinguished from the sepia, by its sac being narrower, and furnished with the membranes for swimming at the posterior part only: whereas that of the sepia, which is very much broader, has a narrow ala, or fin, on each side, extending from the upper margin to the base of the sac. A still more striking difference between the two genera, is derived from the sword, or simple, feather-shaped, horny, transparent, dorsal lamina, belonging to the loligo, which, in every respect, is wholly unlike the lamellar, spongy bone of the sepia.

The internal organization of the two animals is very similar; each secretes a black liquor, which it can eject at pleasure, and probably on similar occasions. The loligines swim at freedom in the sea, and prey on crabs and other marine animals. They deposit their eggs in clusters, like a bunch of grapes, all being attached to a common centre, and forming an orbicular mass.

Type. *Loligo vulgaris* †. (*Sepia loligo*. Linn.)

Alæ semirhomboidal, separate to the extremity of the tail; border of the sac trilobate; dorsal lamina contracted anteriorly. *European Seas*. Pl. vi. Fig. 237.

4. *Sepia* ‡.

Body fleshy, depressed, contained in a sac; sac obtuse posteriorly, and bordered on each side, through its whole length, by a

* Original Latin name for a species of cuttle fish.

† Common.

‡ From *sepio*, to cover, or conceal, because it conceals itself, when pursued, by the ejected inky fluid.

narrow ala. A free, cretaceous, spongy, opaque bone, enclosed in the interior of the body, near the back. Mouth terminal, surrounded by ten arms, furnished with suckers; two of the arms pedunculated, and longer than the others.

The bone enclosed in the body of the sepia, is friable, light whitish, oval, rather thick in the middle, thin and sharp at the edges. It is composed, according to Cuvier, of thin laminæ, in the interstices of which are a multitude of small hollow columns, perpendicular to the laminæ.

The sepia attain a considerable size; some are nearly two feet long. The head, which, with the upper part of the body of the animal, projects beyond the sac, has two large, very remarkable eyes, placed at the sides, and which are the most perfect of those of any of the invertebrated animals; except that they have no eyelids, they appear to be as perfect as the eyes of vertebrated animals. The suckers at the summit of the long arms, serve to keep the animal stationary, whilst it seizes its prey with the shorter ones, which are also furnished with suckers, and are conical, pointed, and rather compressed at the sides. The form of the suckers, when extended, is nearly that of an acorn cup, with a deep circular cartilaginous ring, armed with small hooks, which is secured in a thin membrane, something transparent by the projection of a ledge, investing its whole circumference about the middle of its depth, and not to be extracted without some force.

"Each sucker is fastened by a tendinous stem to the arm of the animal; which stem, together with part of the membrane that is below the circumference of the cartilaginous ring, rises into, and fills its whole cavity, when the animal contracts the sucker for action. In this state, whatever touches it, is first held by the minute hooks, which insinuate themselves betwixt the scales of its prey, and then is drawn up to a closer adhesion, by the retraction of the stem, and inferior part of the membrane, much in the same manner as a sucker of wet leather sustains the weight of a small stone*." The mouth of the sepia is situated at the summit of the

* Needham on the Calamary, p. 22. 1745.

head, in the centre of the arms ; its orifice is circular, membranous, more or less fringed, and contains internally two hard, horny mandibles, similar in form and substance to those of a parrot's bill, which are hooked, and shut one into the other. Within the cavity of the beak is a membrane, furnished with several rows of small unequal teeth. With this formidable weapon, the sepia devours crabs, lobsters, and even shell-fish, which it crushes with its beak, and then completes their trituration in its muscular stomach, which almost resembles the gizzard of a bird.

The bladder which contains the black fluid, called the *sepia ink*, is placed near the *cæcum* ; it is connected with the extremity of the intestinal canal by a small tube, and terminates at the anus, whose orifice opens into the funnel at the anterior part of the body of the animal. By this canal the sepia ejects the inky fluid contained in the bladder, when pursued by an enemy, and escapes the threatened danger, by the obscurity it imparts to the surrounding water. It is said that the indian ink is prepared from the black fluid of some species of sepia.

The sepia are not hermaphrodite, like most of the other mollusca, but consist of male and female individuals ; the latter lay clusters of soft eggs, connected together like a bunch of grapes. They are supposed at first to be yellowish, and to become blackish after they are fecundated.

Type. *Sepia officinalis* *. (Idem. Linn.)

Body smooth on both sides ; pedunculated arms very long ; dorsal bone elliptical. *Mediterranean, English Channel, &c.* †. Pl. vi. Fig. 238. 2 Species.

Fifth Order.

HETEROPODA. (3 Genera.)

Body free, elongated, swimming horizontally. Head distinct ; two eyes. No coronet of arms on the head, nor foot under the belly or neck, for creeping. One or more membranes for swimming, not disposed in regular order, nor in pairs.

* Of the shops.

† In some former instances, *la manche*, (the channel,) has inadvertently been written *la mancha*.

The situation of the heart and branchiæ of the mollusca of this order, is extremely singular; they are placed below the belly, and in many of them are on the outside of it. In this respect, and in the position of the animal whilst swimming, which is horizontal, the heteropoda differ essentially from the pteropoda, which always float in a perpendicular position.

They seem to be more nearly allied to the cephalopoda, but differ from them by having no arms on the head, no mantle, nor the two horny, crooked mandibles, like a parrot's bill, which those animals are furnished with: their organs of motion are also differently disposed.

The body of these mollusca is gelatinous and transparent, and the shell of some of them resembles that of the argonauta.

1. *Carinaria* *.

Body elongated, gelatinous, transparent, terminated posteriorly by a tail, and furnished with one or several unequal alæ. Heart and branchiæ projecting beyond the belly, united in a pendant mass, situated towards the tail, and enclosed in a shell. Head distinct; two tentacula; two eyes; a contractile trunk.

Shell univalve, conical, flattened at the sides, unilocular, very thin, hyaline; summit convolute, spiral; back of the shell sometimes furnished with an indented keel. Aperture oblong, entire.

M. Bory de St. Vincent first observed this singular animal in his voyage to the principal islands of the African seas, and gave a figure of it, with its shell enclosing the principal organs. Subsequently MM. Peron and Le Sueur have given further details of the animal, in the *Annales du Museum*, vol. xv. p. 67.

Type. *Carinaria vitrea* †. (*Patella cristata*. Linn.)

Shell thin, hyaline, transversely sulcated; back furnished with an indented keel; spire conoidal, attenuated; apex very small, involute; aperture contracted towards the keel. *Southern Ocean*. Pl. vi. Fig. 239.

This shell, which M. Lamarck considers as the rarest, most curious, and most precious of all that are contained in the Museum of Natural History at Paris, was presented to it by M. de la Réveillère, Lépaux, in the name of M. Huon, who, after the death of Entre-

* From *carina*, the keel of a vessel. † Glassy.

casteaux, commanded the expedition sent in search of La Peyrouse. It is distinguished from the argonauta, by the spiral summit not entering into the aperture, and by its having a single, sharp, indented keel, the whole length of the back. The animal, moreover, never conceals itself in the shell, which, probably, serves only to protect the heart and branchiæ, which are enclosed within it.

Lamarck gives two other species, *viz.*, *C. fragilis*, from the African Seas, and *C. cymbium*, (*argonauta cymbium. Linn.*) from the Mediterranean; the latter no larger than a grain of sand.

2. Pterotrachea.

3. Phylliroe.

These genera, the last of the mollusca, have no shell.

In parting with our author, we cannot but congratulate and thank him for the essential service he has rendered the science by his admirable work. In his hands conchology has assumed its proper aspect, and from being little better than a vague mass of unconnected descriptions, now forms a regular and important link in the great chain of natural history. If his system be not absolutely faultless, it is at least superior to any other general system extant. In one or two instances, perhaps, Lamarck may have constituted a genus, from characters not sufficiently peculiar to entitle the individual to that distinction. His *castalia*, for instance, seems to be separated from the *unio* on insufficient grounds; and Mr. G. B. Sowerby has, we think very properly, restored it to that genus. Indeed, our author himself appears to have had some doubt on the subject, from the specific name *ambigua*, by which he denominates it.

In point of nomenclature, the work contains some grammatical inaccuracies and inelegancies, which have occasionally surprised us. The names are frequently taken from obsolete Latin terms, when better words might, just as easily, have been adopted, and much confusion prevails in the genders assigned to several of them. Thus, *diceras*, derived from a Greek neuter noun, is made feminine; *pterocera*, similarly derived, should be *pteroceras*, and neuter; as should *anostoma*, but, like *diceras*, they are both made

feminine. *Planaxis* and *argonauta*, which are made feminine, should be masculine; as should *alto triton*, which is made a neuter noun. Other similar oversights may be found, but our limits will not allow us to extend the list, even if we were so inclined; and, after all, the faults are so overbalanced by the merits, that, *non paucis offendemur maculis*. We once more thank M. de Lamarck for the treasure he has given to the world, and heartily bid him farewell.

P. S.—It will be seen by the list of plates, that, in the last we have given the figures of most of these shells, of which we were not able to obtain drawings at an earlier period. Except *clymene*, to which Lamarck gives no reference but the manuscript memoirs of M. Savigny, we believe every genus is now illustrated by an appropriate figure. We have also given a second figure of *planaxis sulcatus*, and another of *carocolla acutissima*, from more characteristic specimens than those from which our former drawings were taken. The figure of the *limacina helicalis* is from a specimen brought to England by Captain Sabine, who accompanied Captain Ross on his expedition to the Arctic Regions. It perfectly answers Lamarck's description of that shell, and also the figure referred to by Otho Fabricius, in his *Fauna Gröenlandica*, which may be found in Adelung's *Geschichte der Schiffahrten*, or History of Voyages to discover a north-east passage to Japan and China, Hallé, 1768. Pl. xvii. Fig. 12.

The following is Mr. Sowerby's specific character of the *galeolaria decumbens*, (Fig. viii. * * *.) "Testâ repente, teretiuscula, dorso obtusè angulatò, sulcato, aperturæ lingulâ breviusculâ." We have not been able to obtain either of the two species described by Lamarck, if, indeed, they be really different from the *G. decumbens*, of Sowerby. Lamarck gives no reference to any figure for either of his species.

Fig. xii. * is *creusia spinulosa*; that described at p. 76, vol. xiv. *C. stromia*, we have not met with; we, therefore, add the specific character of *C. spinulosa*.

Shell turbinated, convex, with four suture; furrows very small, radiating, spinous.

EXPLANATION OF THE PLATES.

N. B. All the Figures are drawn from Nature, except those stated to have been copied from other Works.

PLATE 3. VOL. 14.

Fig.

1. *SILICULARIA anguina.*
2. *Dentalium elephantinum.*
3. *Pectinaria belgica.*
4. *Sabellaria alveolata.* (Ellis.
Tubularia arenosa Anglica.)
5. *Terebella conchilega.* (Ency.
Method. Pl. 67. Fig. 5.)
6. *Amphitriti ventilabrum.* (Ellis.
Pl. 34.)
7. *Spirorbis nautiloides.*
8. *Serpula vermicularis.* (Ellis.
Pl. 38. Fig. 2.)
9. *Tubicinella balænarum.* a. oper-
culum.
10. *Coronula diaderna.* Upper and
under view.
11. *Balanus sulcatus.*
12. *Acasta Montagui.* (Encycl. Bri-
tan. Sup. Vol. 3. Pl. 1. Fig.
57.)
13. *Pyrgoma cancellata,* exterior

Fig.

- and interior view of the shell,
with the valves of the opercu-
lum below.
14. *Anatifa levis.*
15. *Pollicipes cornucopiæ,* the
smaller figure shews the ten-
tacular arms.
16. *Cineras vittata.*
17. *Otion Cuvieri.*
18. *Aspergillum javanum.*
19. *Clavagella echinata.* (Annales
du Museum. Vol. 12 Pl. 43.
Fig. 9. a.)
20. *Fistulana clava.* a. b. the inte-
rior valves.
21. *Septaria arenaria.* b. small end,
shewing the septum. c. large
end.
22. *Teredina personata.* (An. du
Mus. Vol. 12. Pl. 43. Fig. 6.)

PLATE 4. VOL. 14.

Fig.

23. *Teredo navalis.* a. interior of
the tube, shewing the trans-
verse septa. b. the true
shell. c. its two valves. d.
the operculiferous pieces.
24. *Pholas dactylus.* a. interior of
one of the valves, shewing the
internal, dentiform process,
below the umbo.
25. *Gastrochæna cuneiformis.*
26. *Solen vagina.* upper fig. exte-
rior; lower, interior view.

Fig.

27. *Panopæa Aldrovandi,* exterior
and interior.
28. *Glycimeris siliqua.* a. interior
of one valve.
29. *Mya truncata.* a. interior of the
right valve. b. interior of
the left valve
30. *Anatina laterna,* exterior and in-
terior.
31. *Lutraria solenoides.* do. do.

PLATE 5. VOL. 14.

Fig.

32. *Maetra gigantea,* exterior and
interior.
33. *Crassatella Kingicola,* 33 and 33.
a. interior of each valve. b.
exterior of the valves united.

Fig.

- (Sowerby's *Genera of Recent
and Fossil Shells*)
34. 34. a. *Erycina cardioides,* exte-
rior and interior.

- Fig.
 34. *b.* and 34. *c.* *Erycina complanata*, exterior and interior.
 35. *Ungulina transversa*, exterior and interior.
 36. *Solenomya mediterranea*, do. do.
 37. *Amphidesma variegatum*, do. do.
 38. *Corbula nucleus*, do. do.
 39. *Pandora rostrata*. *a.* interior of right valve. *b.* ditto left.
 40. *Saxicava rugosa*, exterior and interior.
 41. *Petricola striata*, do. do.
 42. *Venerupis perforans*. *a.* interior of right valve. *b.* ditto left.
 43. *Sanguinolaria rosea*, exterior and interior.
 44. *Psammobia ferroensis*. *a.* interior of left valve. *b.* ditto right.
 45. *Psammotea donacina*, exterior and interior.
 46. *Tellina radiata*, do. do.
 47. *Corbis limbriata*, valves united, shewing the relative position of the umbones. *a.* exterior of one valve. *b.* interior do.
 48. *Lucina Jamaicensis*. exterior and interior.
 49. *Donax scortum*. side view, shewing the lunula. *a.* exterior of one valve. *b.* interior ditto.
 50. *Capsa lævigata*. exterior of one valve. *a.* interior of left valve. *b.* ditto right valve.

PLATE 6. VOL. 14.

- Fig.
 8.*. *Magilus antiquus*.
 46.*. *Tellinides timorensis*. *a. b.* the two hinges. (*Bowdich's Elements of Conchology*. Fig. 36. *a. b.*)
 51. *Crassina Danmoniensis*. *a.* interior of left valve. *b.* ditto of right do.
 52. *Cyclas rivicola*. exterior and interior.
 53. *Cyrena cor*. exterior and interior.
 54. *Galathea radiata*. *a. b.* interior of right and left valves.
 55. *Cyprina Islandica*. exterior and interior.
 56. *Cytherea lusoria*. exterior of one valve. *a.* back view of the valves united. *b.* interior of right valve.
 Fig.
 57. *Venus puerpera*. exterior and interior.
 58. *Venericardia planicosta*.
 59. *Cardium costatum*. exterior and interior.
 60. *Cardita sulcata*. do. do.
 61. *Cypricardia Guinaica*. do. do.
 62. *Hiatella spinosa*. *a.* left valve. *b.* right valve.
 63. *Isocardia cor*. side view of the valves united. *a.* exterior of one valve. *b.* interior of do.
 64. *Cucullæa auriculifera*. exterior and interior.
 65. *Arca tortuosa*. do. do.
 66. *Pectunculus glycimeris*. do. do.
 67. *Nucula rostrata*.
 68. *Trigonia pectinata*. exterior of one valve. *a.* interior of right valve. *b.* ditto of left.

PLATE 2. VOL. 15.

- Fig.
 69. *Unio sinuata*. exterior and interior.
 70. *Hyria avicularis*. do. do.
 71. *Anodonta cygnea*. do. do.
 72. *Iridina ovata*.
 73. *Diceras arietinum*.
 74. *Chama lazarus*. exterior of one valve. *a. b.* interior of each valve.
 75. *Etheria elliptica*. exterior and interior.
 76. *Tridacna gigas*. back view of the valves united, shewing the open lunula. *a. b.* exterior and interior.
 Fig.
 77. *Hippopus maculatus*. back view, shewing the close lunula. *a. b.* exterior and interior.
 78. *Modiola papuana*. exterior and interior.
 79. *Mytilus Magellanicus*. do. do.
 80. *Pinna rudis*. do. do.
 81. *Crenatula modiolaris*. do. do.
 82. *Perna ephippium*. do. do.
 83. *Malleus albus*. do. do.
 84. *Avicula crocea*. do. do.

PLATE 3. VOL. 15.

- Fig.
 85. *Meleagrina margaritifera*. exterior and interior
 86. *Pedum spondyloideum*. do. do.
 87. *Lima squamosa*. do. do.
 88. *Plagiostoma transversa*.
 89. *Pecten maximus*. exterior and interior.
 90. *Plicatula cristata*. do. do.
 91. *Spondylus gæderopus*. exterior of one valve. *a. b.* interior of right and left valve.
 92. *Podopsis truncata*. exterior and interior. (*Encyclopedie*. Pl. 188. Figs. 6 and 7.)
 93. *Gryphæa angulata*.
 93*. *Gryphæa cymbium*.
 94. *Ostrea edulis*. exterior and interior.
 95. *Vulsella spongiarum*. do. do.
 96. *Placuna sella*. exterior of one valve. *a.* interior of lower valve. *b.* ditto upper.
 97. *Anomia ephippium*. lower valve.

- Fig.
a. interior of ditto. *b.* interior of upper valve.
 98. *Sphærulites foliacea*. (*Encyclopedie*. Pl. 172. Fig. 7.)
 99. *Radiolites rotularis*.
 100. *Calceola sandalina*.
 101. *Briostrites inæquilobus*. (*Sowerby's Gen. of R. and F. Shells*.)
 102. *Crania personata*. exterior of upper valve. *a.* interior of ditto. *b.* interior of lower valve.
 103. *Orbicula Norvegica*. exterior and interior.
 104. *Terebratula vitrea*. front view of the valves united. *a.* interior of larger valve. *b.* interior of smaller ditto, shewing the ramified processes for the support of the animal.
 105. *Lingula anatina*. exterior and interior.

PLATE 7. VOL. 15.

- Fig.
 106. *Hyalæa tridentata*.
 107. *Balantium recurvum*.
 108. *Cleodora pyramidata*. (*Ann. du Mus.* 15. Pl. 2. No. 14.)
 109. *Cymbulia Peronii*. (*Ann. du Mus.* 15. Pl. 3. No. .)
 110. *Chitonellus lævis*.
 111. *Chiton squamosus*.
 112. *Patella granatina*.
 113. *Pleurobranchus Peronii*. (*Ann. du Mus.* Tom. 5. Pl. 18. Fig. 3.)
 114. *Umbrella Indica*. *a.* under side of the shell.
 115. *Parmophorus Australis*.
 116. *Emarginula fissura*.
 117. *Fissurella nimbosa*.
 118. *Pileopsis ungarica*.
 119. *Calyptræa equestris*. *a.* under side.
 120. *Crepidula fornicata*. *a.* under side.
 121. *Ancylus lacustris*.
 122. *Bullæa aperta*.
 123. *Bulla lignaria*.
 124. *Laplysia depilans*.
 125. *Dolabella Rumphii* *a.* concave side.
 126. *Parmacella caliculata*. under and upper side,

- Fig.
 127. *Limax rufus*.
 128. *Testacella haliotide*. *a.* under side.
 129. *Vitrina pellucida*. upper and under side.
 130. *Helix gigantea*.
 131. *Carocolla accutissima*.
 132. *Anastoma depressum*.
 133. *Helicina neritella*.
 134. *Pupa mumia*.
 135. *Clausilia torticollis*: the small figures below represent the two valves of the penultimate whorl.
 136. *Bulimus hæmastomus*.
 137. *Achatina perdix*.
 138. *Succinea amphibe*.
 139. *Auricula Midæ*.
 140. *Cyclostoma volvulus*.
 141. *Planorbis corneus*.
 142. *Physa fontinalis*.
 143. *Lymnæa stagnalis*.
 144. *Melania truncata*.
 145. *Melanopsis lævigata*.
 146. *Pirena terebralis*.
 147. *Valvata piscinalis*.
 148. *Paludina vivipara*.
 149. *Ampullaria Guyanensis*.

PLATE 8. VOL. 15.

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| <p>Fig.
150. <i>Navicella tessellata</i>. <i>a.</i> under side.
151. <i>Neritina pulligera</i>.
152. <i>Nerita exuvia</i>.
153. <i>Natica glaucina</i>.
154. <i>Ianthina communis</i>.
155. <i>Sigaretus haliotideus</i>. under and upper side.
156. <i>Stomatella sulcifera</i>. do. do.
157. <i>Stomatia phymotis</i>.
158. <i>Haliotis Iris</i>.
159. <i>Tornatella flammea</i>.
160. <i>Pyramidella dolabrata</i>.
161. <i>Vermetus lumbricalis</i>.
162. <i>Scalaria pretiosa</i>.
163. <i>Delphinula laciniata</i>.
164. <i>Solarium perspectivum</i>.</p> | <p>Fig.
165. <i>Rotella lineolata</i>.
166. <i>Trochus imperialis</i>. <i>a.</i> under side.
167. <i>Monodonta pagodus</i>.
168. <i>Turbo marmoratus</i>.
169. <i>Planaxis sulcatus</i>.
170. <i>Phasianella bulimoides</i>.
171. <i>Turritella duplicata</i>.
172. <i>Rissoa</i>.
173. <i>Cerithium palustre</i>.
174. <i>Pleurotoma Babylonia</i>.
175. <i>Turbinella cornigera</i>.
176. <i>Cancellaria reticulata</i>.
177. <i>Fasciolaria tulipa</i>.
178. <i>Fusus colus</i>.
179. <i>Pyrula caliculata</i>.</p> |
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PLATE 5. VOL. 16.

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| <p>Fig.
180. <i>Struthiolaria nodulosa</i>.
181. <i>Ranella gigantea</i>.
182. <i>Murex brandaris</i>.
183. <i>Triton variegatus</i>.
184. <i>Rostellaria curvirostris</i>.
185. <i>Pterocera lambis</i>.
186. <i>Strombus latissimus</i>.
187. <i>Cassidaria echinophora</i>.
188. <i>Cassis glauca</i>.
189. <i>Ricinula horrida</i>.
190. <i>Purpura persica</i>.
191. <i>Monoceros imbricatum</i>.
192. <i>Concholepas Peruvianus</i>.
193. <i>Harpa ventricosa</i>.
194. <i>Dolium perdix</i>.</p> | <p>Fig.
195. <i>Buccinum undatum</i>.
196. <i>Ebema glabrata</i>.
197. <i>Terebra maculata</i>.
198. <i>Colombella mercatoria</i>.
199. <i>Mitra episcopalis</i>.
200. <i>Voluta diadema</i>.
201. <i>Marginella glabella</i>.
202. <i>Volvaria bulloides</i>.
203. <i>Ovula oviformis</i>.
204. <i>Cypræa cervina</i>.
205. <i>Terebellum subulatum</i>.
206. <i>Ancillaria cinnamomea</i>.
207. <i>Oliva porphyria</i>.
208. <i>Conus marmoreus</i>.</p> |
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PLATE 6. VOL. 16.

- | | |
|--|--|
| <p>Fig.
8**. <i>Vermilia rostrata</i>. <i>a.</i> the beak of the aperture.
8***. <i>Galeolaria decumbens</i>. natural size. <i>a.</i> operculum — very much magnified. <i>b.</i> aperture ditto. (<i>Sowerby's Gen. of R. and F. Shells</i>, No. 11.)
12*. <i>Creusia spinulosa</i>. <i>a.</i> operculum.
68*. <i>Castalia ambigua</i>. exterior of one valve. <i>a. b.</i> interior of both valves.
108*. <i>Limacina helicalis</i>. upper and under side.
131*. <i>Carocolla acutissima</i>.
169*. <i>Planaxis sulcatus</i>.</p> | <p>Fig.
209. <i>Belemnites subconica</i>. (<i>Trans. R. S. E.</i> Pl. 25. Fig. 3.)
209*. ——— mamillata.
210. <i>Orthocera raphanus</i>. <i>a.</i> nat. size. (<i>Ency.</i> Pl. 465. Fig. 2. c.)
211. <i>Nodosaria radícula</i>. <i>a.</i> nat. size. (<i>Ency.</i> Pl. 465, Fig. 4. b.)
212. <i>Hippurites rugosa</i>. <i>a.</i> larger end.
213. <i>Conilites</i>. pyramidata, (<i>Sowerby's Min. Con.</i> No. 46. Pl. 260. Fig. 3.)
214. <i>Spirula Peronii</i>.
215. <i>Spirolinitis cylindracea</i>. (<i>Ency.</i> Pl. 466. Fig. 2.)
216. <i>Lituolites nautiloidea</i>. (<i>Ency.</i> Pl. 465. Fig. 6.)</p> |
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- Fig. 217. *Renulites opercularis*. (*Ency.* Pl. 465. Fig. 8.)
218. *Cristellaria squammula*. *a.* nat. size. (*Fichtel.* Pl. 16. *b.*)
219. *Orbiculina numismalis*. *a.* nat. size. *b.* transverse section, shewing the chambers. *c.* side view, shewing the aperture. (*Fichtel.* Pl. 21. *a. b. c. d.*)
220. *Miliolites coranguinum*. (*Ency.* Pl. 469. Fig. 2. *a. b.*)
221. *Melonites sphærica*. *a.* nat. size. (*Fichtel.* Pl. 24. *b.*)
222. *Rotalites trochidiformis*. upper and under side.
223. *Lenticulites rotulata*. (*Ency.* Pl. 466. Fig. 5.)
224. *Placentula pulvinata*. *a.* nat. size. (*Fichtel.* Pl. 3. *b.*)
225. *Discorbites vesicularis*. (*Ency.* 466. Fig. 7. *a.*)
226. *Siderolites calcitrapoides*. *a.* nat. size. *b.* transverse section. (*Fichtel.* Pl. 15. *e. k.*)
227. *Polystomella crispa*. *a.* nat. size. *b.* side view. *c.* transverse section. (*Fichtel.* Pl. 4. *d. e. f.* and Pl. 5. *b.*)
- Fig. 228. *Vorticialis craticulata*. *a.* nat. size. *b.* side view. (*Fichtel.* Pl. 5. *h. i. k.*)
229. *Nummulites lævigata*.
230. *Nautilus pompilius*.
231. *Ammonites Königi*. (*Sowerby's Min. Con.* No. 46. Pl. 263. Fig. 3.)
232. *Orbulites subradiata*.
233. *Ammonoceratites glossoidea*. (*Bowdich.* Pl. 3. Fig. 14.)
234. *Turrilites costulata*. (*Sowerby's Min. Con.* Pl. 36.)
235. *Baculites Faujasii*.
236. *Argonauta Argo*.
237. *Loligo vulgaris*—the corneous lamina very much reduced. *a. b.* cranium—nat. size. *c.* the beaks united. *d. e.* its parts separate—*f.* indented ring of the sucker.
238. *Sepia officinalis*, the shell very much reduced. *a.* beak. *b.* sucker ring. *c.* egg. All nearly the natural size.
239. *Carinaria vitrea*. (*Ency.* Pl. 464. Fig. 3.)

ERRATA.

Vol. xv. p. 219, line 26, for "*air-holes*," read "*suckers*."

Vol. xv. p. 248, line 8, for "*nerita*," read "*natica*."

ART. VII. *Experiments on the Proportion of Charcoal obtained from Woods having a greater Specific Gravity than Box.* By Mr. T. Griffiths.

THE pieces of wood, having their respective weights carefully taken, were put into crucibles covered with sand, which were placed in a strong heat, till all the volatile products were dissipated. The charcoal thus obtained was weighed whilst warm, in order to prevent any inaccuracy that might have been occasioned by the absorption of moisture from the air. Of the many different woods that might have been employed, eight specimens have been selected, and the result of the experiments made upon them, are

detailed in the following tables; the first of which shews the specific gravity of the different woods. The second table shews the proportion of charcoal in one hundred parts of the respective woods.

In the third table the specific gravity of the charcoal is taken in the following manner. Its weight was taken in air, with its surface slightly varnished, which, when it was weighed in water, prevented that fluid from filling its pores. But this method not giving the true specific gravity of the charcoal as its pores were filled with air, another was adopted, in which the charcoal having been weighed in air was put at the bottom of a glass of water under an exhausted receiver where it remained several hours till the air it contained was expelled. Upon removing the receiver the charcoal was saturated with water by the pressure of the atmosphere upon its surface. In this state it was weighed in water; the specific gravities obtained by this method are given in the fourth table.

In regard to electrical conducting power, charcoal from satin wood is the best, and charcoal from tulip wood the worst. The other specimens discharge a battery with nearly equal energy.

TABLE 1.

Lignum Vitæ	1.342
Cocoas wood	1.336
Ebony	1.226
Brazil wood	1.132
Satin wood	1.078
Tulip wood	1.070
King wood	1.069
Botany Bay wood	1.067

TABLE 2.

Ebony	30.5
Botany Bay wood	28.1
Brazil wood	26
Cocoas wood	22.5
King wood	22
Tulip wood	20.8
Satin wood	20.7
Lignum Vitæ	17.5

TABLE 3.

Lignum Vitæ	0.94
Ebony	0.93
Cocoas wood	0.86
Tulip wood	0.76
Botany Bay wood	0.57
Satin wood	0.55
King wood	0.7
Brazil wood	0.6

TABLE 4.

Lignum Vitæ	1.84
Cocoas wood	1.36
Satin wood	1.26
Tulip wood	1.17
Botany Bay wood	1.12
King wood	1.04
Ebony	1.4
Brazil wood	0.84

ART. VIII. *Description of Mr. Rider's Rotatory Steam-Engine. (With a Plate.)*

[To the Editor of the QUARTERLY JOURNAL OF SCIENCE.]

Belfast, August 27, 1823.

SIR,

A VARIETY of occurrences have, until now, induced me to decline publishing on the subject of my rotatory steam-engines. My principal reason was, that I did not wish to appear before the public until the matter, from actual experience, and deliberate trial, was placed beyond a doubt of success. I feel the greater satisfaction in informing you that I consider this desirable object is now attained, there being three engines on my principle at present working at different places in this neighbourhood with the greatest success, one of which is twelve, one sixteen, and the other twenty horse power.

I send you herewith drawings, and a description of my rotatory engine, through my friend Mr. Boyd ; and should you still entertain the same favourable opinion of the improvement, which you were pleased to express to him, I shall feel much obliged by your taking such notice of it as you think it deserves, in the Journal which you conduct.

The advantages which these engines possess, are, that they require less room, less weight, consume less fuel, and are cheaper than the common engine ; beside the expense of foundation work, and buildings necessary for erection, is considerably reduced.

By this important improvement, so long sought after, the operation of the steam on the piston, from its first action, is completely uniform, and may be communicated to any purpose required, without the loss of power occasioned by the use of lever beams, crosses, cranks, fly wheels, or balances of any description.

For steam navigation these engines are peculiarly adapted, where the saving of room and weight is an object of much importance.

Fig. 1.

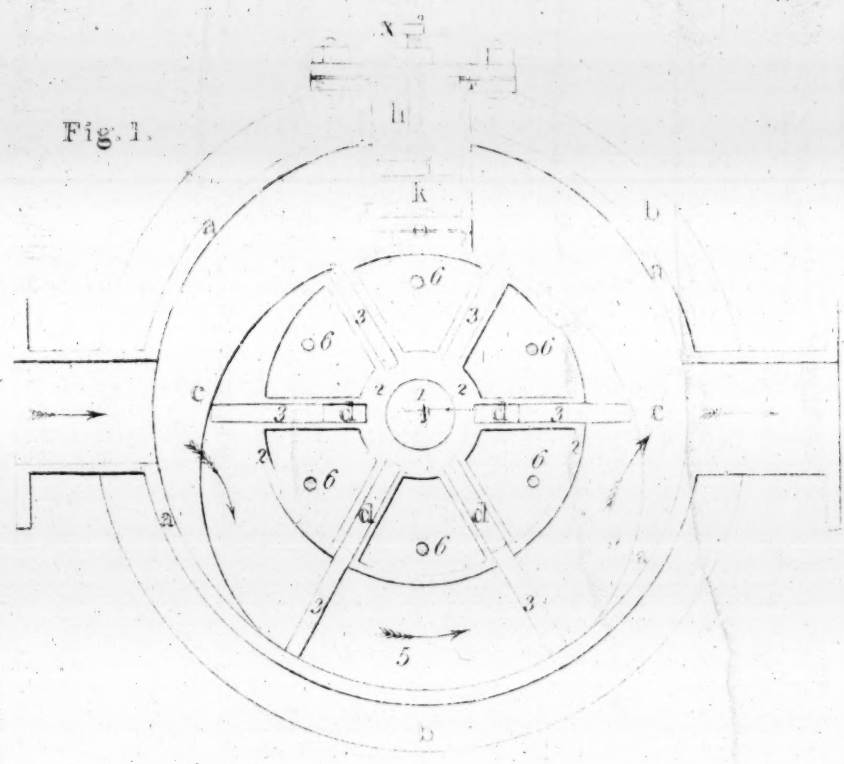
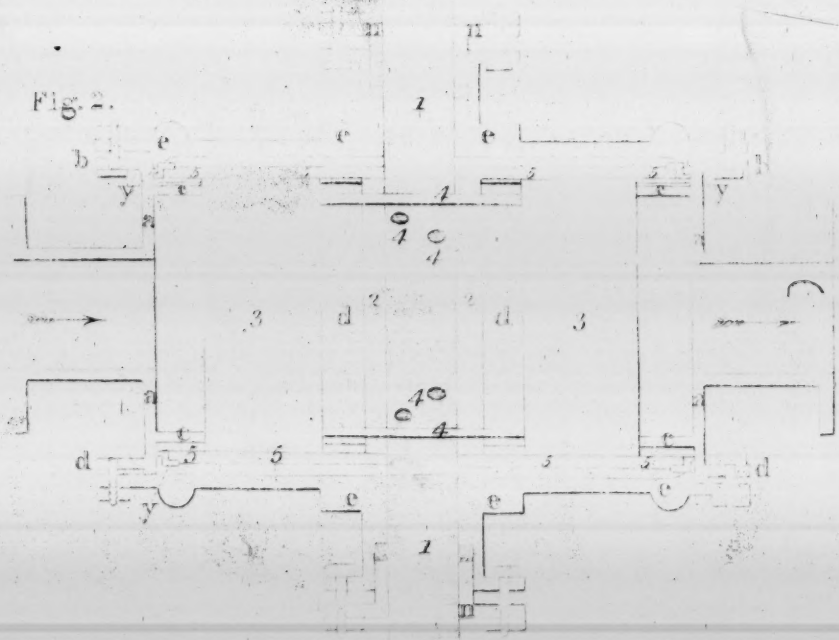


Fig. 2.



J. Besant sc.

Should you think any farther information than what is now communicated necessary, I shall feel great pleasure in affording it.

I am, Sir,

Your most obedient servant,

J. RIDER.

*Description of a Patent Rotatory Steam-Engine, manufactured by
Job Rider and Co., Belfast.*

Plate IX. The two figures show the parts of a twenty-horse engine, the same marks of reference are used to denote the same parts in both. Fig. 1, is a section cut through the centre at right angles to the axis. Fig. 2, is a middle section cut through the centre of the axis.

Fig. 1 and 2, the fixed parts are *aaaa*; the outside cylinder has a flanch *bb* near each end, and two internal eccentrics *cc*; on the outside of it are two flanch'd branches $\longrightarrow$, one of which connects the engine with the boiler, the other with the condenser. It is covered with two ends, *eeee*, (as shewn in Fig. 2,) each end having a centre flanch'd branch, into which is fitted a flanch'd socket *DD*, screwed down on hemp packing, shewn by dotted shade.

The revolving parts are 1, 1, the inside cylinder (which is fixed on the axis 2.2.2.2.) has six cavities, or interstices, *d.d.d.*, into which are fitted sliding valves 3.3.3.3.; upon each end of it are fitted flanches (Fig. 2,) 5.5.5.5. shewn by the sloping lines; these flanches are screwed together through the arms of the cylinder, as shewn by 6.6.6.6. (Fig. 1,) each flanch having grooves proceeding to its extremity, equal in depth to the rabbet of the flanches upon the cylinder, and corresponding with the valve recess *dd*, in the inside cylinder 2.2.2. The sliding valves are made to work steam tight in these grooves; they are connected by ground steel pins, which pass through the axis, as shewn in Fig. 2, by 4.4.4.4. These pins keep the edges of the sliding valves close to the (fixed) outside cylinder, both in its eccentric and concentric parts (as shewn Fig. 1,) during the time that the inside cylinder, with its flanches and sliding valves, are turned upon their axis.

The sliding valves are at their full extent when passing the

lower concentric part of the outside cylinder, at which place the power is obtained, and they are close in the recesses of the inside cylinder when passing the upper concentric part.

Fig. 1, *r.r.r.r.* is an oblong flanced box, which has a cover screwed to its flanch; through the cover are screws with guard rivets XD, which press down the hemp packing *k*, by means of the plate 1, keeping the piece of brass *o* close to the inside cylinder 2.2.2.2.

The ends of the piece of brass *o* come close to the inside of the revolving flanches, and a packing is completely formed between the outside of the upper concentric part (in the eccentric CC.) and the inside of the revolving flanches 5.5.5.5.

Fig. 2, *yy*, are sections of rings kept close to the outside of the revolving flanches 5.5.5.5. by spiral springs placed in the thick part of the cover *eeee*.

The engine is placed between the boiler and condenser, the boiler producing, and the condenser destroying, steam. It has on the boiler-side a pressure of steam, and on the condenser-side nearly a vacuum, the steam-gauge standing at six inches of mercury more than the pressure of the atmosphere, and the vacuum-gauge standing at 26 inches less. This gives a power of 16 pounds on the square-inch.

The course of the steam gives a velocity of 600 feet per minute of a revolving motion, to the extremity of the sliding valves, and forces round the inside cylinder 2.2.2.2. and the shaft 1. Fig. 1. $\longrightarrow \longrightarrow$ show the course of the steam from the boiler to the condenser, according as the engine is connected to them.

The engine can be made so that the motion may be reversed at pleasure. The air-pump and under work belonging to the engine, which are not shewn in the plate, may be made on the common construction.

[To the Editor of the QUARTERLY JOURNAL OF SCIENCE.]

Fort Breda, 27th August, 1823.

SIR,

In addition to Mr. Rider's letter explanatory of the advantages

his engines possess over the common ones, I have only to add, that like many others not professionally occupied with the science of mechanics, I had my doubts as to the superiority of his invention; and it was not until I had the experience of ocular demonstration, confirmed by the judgment of people versed in steam-engines, that my prejudices were removed; but having witnessed the engines he mentions in his letter to you, at work, and hearing the favourable report of all parties, I now confess myself a complete convert. The chief objections urged against these engines, is the fear of greater wear than in others. Now this has been quite satisfactorily proved to be even less. The engine at Messrs. Grimshaw's, (a twelve-horse power,) after working all last summer, and driving all the machinery of the printfield, day and night, (for there was no supply of water to drive the wheel,) was taken asunder, and the sliding valves and water cylinder examined, when no apparent wear or tear was visible, although during the entire period it had never been fresh packed. This was the first engine made of the kind, except the model one at the foundry. It was warranted equal in power and durability to an engine of twelve-horse power on the old construction, and the time of payment left to Messrs. Grimshaw's discretion. They are now so well satisfied that they have paid for it, and so they well might, as it does not require more than half the fuel necessary for one of the best engines on the old principle! The sixteen-horse engine to which Mr. Rider alludes, is at Messrs. Bell's Bleach-works, Ballyclare, where it affords the greatest satisfaction. The twenty-horse engine is at Messrs. Alexander's flour-mills. It drives three pair of mill stones with a full feed of grain, and could readily drive a fourth pair, did the connecting machinery answer, with a pressure of from four to six inches on the mercurial gauge. In fact, the real power of these engines is yet unknown, and the multifarious advantages attending them are such as to demand the serious attention of all manufacturers, and others who have machinery to drive.

I am sure you will feel great pleasure in giving publicity to this invention through your widely circulated Journal, it being one of the greatest importance to the arts and manufactures; and which,

in my humble opinion, bids fair to constitute one of the greatest improvements yet made in the steam-engine.

I had almost forgotten to mention a circumstance which has, doubtless, operated against the good name of this invention in Glasgow, *i. e.*, the bad success attending the engine put on board the Highland-lad steam-vessel, by Messrs. Girdwood and Co., through Mr. R.'s license. In consequence of the evil reports (which were *industriously circulated*,) Mr. R. and I went to Glasgow, where, on inspection, we found the engine differed most materially from his plan, and was extremely defective indeed, so much so, that it is wonderful it had any power whatever. By way, however, of letting the good folk on the other side of the water witness the astonishing effect of his improvement, he is now engaged in constructing an engine to be mounted in a boat at Glasgow, where all may have an opportunity of judging for themselves.

I have the honour to be,

Sir,

Your most obedient servant,
WILLIAM BOYD.

ART. IX. *Observations on the Modern Theory of Physical Astronomy.* By John Walsh, Esq.

[Communicated by the Author.]

MEN, in general, are too apt to form theories without thoroughly examining the bases on which they found them, and the consequences that may follow from them; and, as well as others, the geometer and the natural philosopher have often committed themselves in this way. When the geometer departs from the spirit of demonstration, he is no longer to be depended upon. Sometimes I meet, even in the works of the most illustrious mathematicians, with the expression, "rigorous demonstration." This sounds oddly; I cannot perceive the necessity of the word rigorous, or of any adjunct of similar meaning, as applied to demonstration. Both sides of an equation, being only different manners of repre-

fore, $A m$ cannot represent the second impulse of the central force. Then, therefore, the first law of Kepler, if true, is not yet demonstrated to be true.

Let us now try if any other law, more conformable to the nature of analysis, and the spirit of demonstration, can be substituted in the place of the inverse ratio of the square of the distance, to show the variations of the force with which any two attracting points act on each other, when at any distance asunder.

When the points are in contact, the spaces which they would uniformly describe in the same time by their total actions on each other, were they free to move, would be inversely as their forces. Let C be the straight line, which any of them may uniformly describe in any given time, by an action equal to that, which the other point would exercise on it when in contact with it; and let x be the distance of this point from the point of contact, which I call the centre of gravity of the two attracting points; then, $\frac{c^3}{(c+x)^2}$ will always represent the force whatever may be x . And no other can be the law of universal gravity, if such a principle exists. Let a and y correspond to the second attracting point, then we shall have for the relation between the forces with which they act on each other, $\frac{c^3(a+y)^2}{a^3(c+x)^2}$ a constant quantity, whatever may be x and y .

JOHN WALSH.

ART. X. *Description of a Grotto in the Interior of the Colony of the Cape of Good Hope. By Mr. G. Thompson.*

[Communicated by the Rev. F. Fallows.]

THE Grotto is situated in the Kango, in the district of George, about 350 miles from Cape Town. It was first discovered by a Mr. Botha, a farmer, by accident, when on a hunting party, and a few days afterwards it was entered by him and a party of farmers; this occurred in the year 1780.

The hill, where the grotto is, is between 5 and 600 feet in

height, being part of an extensive chain of calcareous mountains which divides the Kango country from the great Kaaroo or desert. The entrance is at the height of about 100 feet from the level of a brook which passes close to the hill. The door-way or entrance is about 20 feet high, and a most romantic excavation. From the entrance you are led in nearly a horizontal direction for 200 feet, when a precipice of 33 feet presents itself, and which is descended by a ladder into *Van Zeily's Hall*, (named after the discoverer, as are likewise the other chambers,) a most wonderful subterranean vault about 100 feet broad, varying in height from 60 to 70 feet, and measuring in length about 600 feet. The scenery in this cavern is grand and awful in the extreme, adorned with the most splendid stalactites, which were greatly beautified by the glare of torches, some of the columns rising to the height of 40 feet, (caused by a single drop of water from the roof,) others appearing in the shape of cauliflowers, festoons, and assuming all kinds of fantastic forms. The next apartment is the Registry (from the names being wrote upon the walls) about 40 feet broad, and 25 feet high. From this we are led to Botha's Hall, about 140 feet broad and 50 feet high; adjoining this is the south chamber, a small place about 30 feet long, 15 broad, and 20 high, which leads to Vander-West-huissen's Chamber, 15 feet high, 10 long, and as many broad; from this we are led to Thom's Chamber, 14 feet long, 8 broad, and 15 high. At the end of this last mentioned apartment a precipice of 14 feet, prevented others exploring this grand cavern, however I ventured down, followed by three slaves, who all lost their torches in the descent, and fell neck over heels; fortunately my light was secured, when I proceeded first into what I take upon myself to call "George Thompson's Chamber." This I fully explored, and found it about 500 feet long, 50 broad in some parts, and varying in height from 20 to 40 feet. This is the extremity of the cavern, which I presume may be upwards of 1500 feet from the entrance. On the right, near the ladder, is Bat Corner, or Fledermuishoek. The Rhombus is on the right of Van Zeily's Hall. The Pyp or Yzicle Chamber, and the Bath-house are also on the right of Botha's Hall. The passage between

274 *Description of a Grotto at the Cape of Good Hope,*

the South Chamber and Vander-West-huissen's Chamber is so narrow as scarcely to admit a large person, and is called Botha's Poort or door, likewise Nel's Poort, is equally narrow between Vander-West-huissen's and Thom's Chamber. These apartments constitute the whole of this very extensive series of subterraneous caverns; and should there be any other apartments, they must communicate by a very small passage, as I narrowly examined every part. The beauty of some of the chambers cannot be described. The production of the stalactites is very surprising; a single drop of water from the roof, in time will raise a column 50 feet high. A great many drops have produced cauliflowers, pulpits, and other beautiful and romantic festoons, shewing the remarkable action of water, and carbonic acid upon calcareous rock. The Bath-house contains several basins of clear water. Innumerable quantities of bats have taken up their residence here, (apparently from the excrement,) from time immemorial—they are the only inhabitants of these lonely regions. The heat is great, and even oppressive at the farthest extremity. Had this beautiful grotto been situated where it was more accessible to mankind, and not so far in the wilds of a desert country, we should ere this time have seen a proper account of it, by which means it would have been plucked from the obscurity which shrouds it at present, and have gratified the eyes of the curious, and the lovers of the sublime.

ART. XI. *On some undescribed Minerals.* By H. J. A. Brooke, Esq., F.R.S.

Childrenite.

ABOUT four years since I purchased at Tavistock, in Devonshire, three specimens of a mineral, said to have been taken from some part of the ground which had been perforated for the canal lately completed there. They were supposed to be carbonate of iron, but it was obvious on looking at the crystals that they must belong to some other substance.

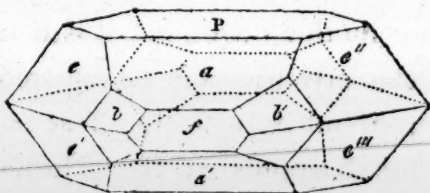
Intervening occupations prevented me for a long time from ex-

aming them, but it is now several months since I ascertained from the measurement of their angles that they differed from the crystals of every other known mineral. They are so very minute, that the whole quantity I possess would weigh only a few grains. A part of one of the specimens, however, enabled Dr. Wollaston to ascertain that the mineral was a *Phosphate of Alumina and Iron*.

The attention which Mr. Children has shewn to mineralogical chemistry, is one, among many other inducements to name this mineral *Childrenite*.

The form of the crystals is represented by the accompanying figure, except in this particular, that the planes marked *b*, in the figure, generally consist of a number of very narrow planes with parallel edges, but whose inclinations upon *e*, I have not been able to measure.

P on <i>e</i> or <i>e''</i>	. 114° 50'
P on <i>a</i>	. . . 152 10
P on <i>f</i>	. . . 90
<i>e</i> on <i>e'</i>	. . . 130 20



I have not succeeded in cleaving the crystals, but we may assume a *right rhombic prism* as their *primary form*; and if we suppose the planes *e* to be produced by decrements upon its terminal edges, the lines between *e e'*, and *e'' e'''*, would obviously lie on the lateral primary planes, and the inclination of these planes would then be 92° 48'.

If the planes *e* result from a decrement, by one row of molecules, the terminal edge would be to a lateral edge, nearly as 13 to 28, and the planes *a* might then be represented by the symbol $\frac{6}{A}$.

The crystals slightly scratch glass. Their colour is wine yellow. And in the only specimens I have seen they occur on the surface of crystallized quartz, and might be mistaken by a casual observer for sulphate of barytes.

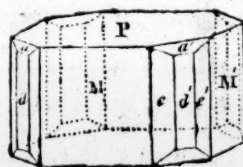
Somervillite.

The next mineral I shall have to describe came to me with some

other Vesuvian substances, from Dr. Somerville, from which circumstance I have named it *Somervillite*.

Its *primary form* is a *right square prism*, but the crystals are modified on the solid angles and lateral edges, as in the annexed figure.

P on <i>a</i>	. .	147° 5'
P on M	. .	90
M on <i>e</i>	. .	161 33
M on <i>d</i>	. .	135
M on M'	. .	90



Assuming the planes *a* to result from a decrement by one row of molecules, the terminal edge of the *primary form* would be to the lateral edge, as 16 to 25 nearly. The planes *e* result from a decrement by three rows in breadth on the lateral edges.

The crystals may be cleaved easily parallel to the terminal planes, but imperfectly, if at all, parallel to the lateral planes or to the diagonals of the prism. Their colour is a very pale dull yellow.

The substance for which this might at first view be mistaken is the *idocrase*, although no plane corresponding in its inclination on P with the plane *a* of the preceding figure, has yet been observed on any crystal of that substance. But these crystals are much softer than *idocrase*, the cleavage parallel to the terminal planes much more distinct, and the cross fracture more glassy.

They occur in cavities, with crystallized black mica, and with another substance which I have not yet examined; and the mass to which they adhere appears to be nearly all *Somervillite*, intermingled with black mica.

Mr. Children has taken the trouble to compare the characters of this mineral under the blow-pipe, with those of *idocrase*.

When exposed alone in the forceps it slightly decrepitates, which *idocrase* does not, and fuses, with greater difficulty than *idocrase*, into a greyish glass, the globule from *idocrase* being greenish. With borax, in the reducing flame, *idocrase* produces a light green, and this a colourless glass.

Kupferschaum.

I do not find any analysis published of the mineral termed *Kupferschaum* by the Germans, which is the same as the fibrous or flaky bright green substance found at Matlock.

It dissolves entirely and with effervescence in muriatic acid. From this solution a bulky precipitate is thrown down by caustic potash, a considerable part of which is redissolved by an excess of the alkali, leaving a residuum of *hydrate of copper*. If the solution be filtered to separate the copper, and acetous acid be added, a white flocculent precipitate appears, which may be redissolved by an excess of acid or of alkali. As this is a marked character of oxide of zinc, I conclude that the mineral is a *carbonate of copper and zinc*.

ART. XII. *On a Mountain Barometer constructed with an Iron Cistern.* By J. Newman, *Philosophical Instrument-Maker to the Royal Institution of Great Britain.*

[To the Editor of the Quarterly Journal.]

SIR,

I TAKE the liberty of sending you an account of an alteration I have made in the construction of Mountain Barometers, and which has been declared highly satisfactory and important, by those who have made trial of instruments so constructed. The object has been to correct those defects and errors which arise from the use of a wooden cistern and leather bag, in the common instrument. It has been found that when the cistern is made of a wood sufficiently sound and close-grained to permit of the pressure required from the screw to make the instrument portable, that it is so impervious to air, as not to allow it to pass with sufficient freedom, and consequently, that when the instrument is used at any great altitude, the mercury cannot fall into the cistern except with considerable difficulty, and a long time is required before an accurate observation of the air's pressure can be made ; most generally, however, the cistern is sufficiently pervious to air, but it is then found that on

screwing up the mercury to the top of the tube, a portion of the metal generally makes its way through the wood, thus soon rendering the instrument quite useless; for it is very evident that a barometer that loses a portion of mercury from the cistern by making it portable or otherwise after it is adjusted, can no longer be correct or give the height of the column.

To obviate these inconveniences, I have substituted a cistern of iron in place of the wooden one; it is fastened to the tube by a thick collar of wood, which is glued on in the usual manner; a screw passes through the centre of the bottom, so as to move in a line with the barometer tube; it is terminated inside the cistern by a piece of cork tied over with leather, so that the instrument being inclined that the tube may be filled with mercury, this cork may be screwed up against the end of the tube, and effectually preserve the metal within from oscillation, without subjecting the cistern itself to any pressure.

As there is no pressure on the mercury in the cistern, the wooden cap may be left so porous in one part, as to allow of the ready access of air, so that the column shall fall freely to its proper level, without any danger of losing mercury.

Another great object in a mountain barometer, is to obtain the temperature of the mercury, which is done by fixing a thermometer with the bulb in the cistern; I have found that by carrying a barometer in my hand and near the body, the temperature is increased considerably, and will frequently rise as high as 85° F.

In the barometer of common construction, the height of the column of mercury is marked off from another instrument, presumed as a standard, and in that case, the actual height is rarely or ever given, for every change that takes place in the weight of the atmosphere, alters barometers more or less according to the proportion which the diameters of the tubes bear to those of the cisterns, and for that reason, upon examining twenty barometers no two will agree, unless they were marked off together, and happen to stand at that exact height.

To remedy this source of error each instrument may be reckoned a standard, the height of the column is marked off from the sur-

face of the mercury, and the point given at which it was marked off; when with the correction for the capacities of the tube and cistern, and also the temperature, the actual height of the barometer is ascertained. Upon examining the first four which I made independent of each other on this principle, one for Mr. Daniell, one for the Royal Society, and two for Captain Sabine, they agreed within .004 of an inch with each other.

ART. XIII. *Observations on the Ultimate Analysis of certain Vegetable Salifiable Bases.* By W. T. Brande, Esq., Sec. R.S., and Professor of Chemistry in the Royal Institution.

SINCE the discovery of a peculiar crystallizable substance, possessed of alkaline properties, in opium, by M. Sertuerner, in the year 1816, a variety of analogous salifiable bases have been detected in, and separated from, other vegetable products. Among these none are more remarkable than the two substances discovered in certain species of the genus *Cinchona* by Messrs. Pelletier and Caventou, in the year 1818. To that separable from the common pale Peruvian bark, (*Cinchona Lancifolia*.) they have given the name of *Cinchonin*; and of *Quinine*, to that obtained from the yellow bark, (*Cinchona Cordifolia*.) They have also ascertained that the red bark contains no distinct principle, but that it derives its virtues from a mixture of those existing in the two varieties just named. In conformity with the principles of chemical nomenclature adopted in this country, the former may be called *Cinchonia* and the latter *Quinia*.

The essential medical virtues of opium, cinchona, and of the other substances in which they have been found, appear, in all cases, to depend upon these newly-discovered bodies, and in this respect they promise to form very important articles in the *Materia Medica*; and they are particularly interesting to the chemist, as constituting a distinct class of salifiable bases, possessed of

some of the properties of alkaline bodies, and presenting a curious contrast in their ultimate composition, to the vegetable acids especially, and to the proximate products of the vegetable kingdom in general.

In examining morphia, very soon after its discovery, I was much struck with the peculiar products which it appeared to afford when submitted to ultimate decomposition; I did not, however, at that time pursue the subject, conceiving that it would form a part of the inquiries of its discoverer. But I have since recognised the same peculiarities in cinchonia and quinia, and the views of their nature, to which my experiments have led me, are very different from those of Messrs. Pelletier and Caventou*, and appear important in respect to the ultimate composition of vegetable bodies in general.

These substances agree in being difficultly soluble in water, in alcohol, and in ether, at common temperatures, but they dissolve in considerable proportion in boiling alcohol, which deposits them as it cools. Morphia, cinchonia, and strychnia, are thus obtained in the crystalline form; quinia is uncrystallizable, and separates as the alcohol cools, in the form of a viscid mass, somewhat resembling birdlime. They are tasteless, or only slightly bitter, in their pure and dry state, but the addition of the smallest portion of acid gives rise to intensely bitter compounds. When exposed to a moderate heat they exhibit no signs of water of crystallization, but at higher temperatures they fuse like resins, and concrete on cooling, with the exception of quinia, into a radiated crystallized mass. At a temperature of 300° , cinchonia decrepitates, and at 450° it fuses, becomes brown, and a portion sublimes and condenses on cooling in brilliant acicular crystals which resemble the original substance.

At a red heat these substances are all decomposed with nearly similar phenomena, and the results are remarkable as presented by a vegetable body. Under these circumstances they produce great abundance of ammonia, which is easily recognised by its

* *Annales de Chimie et Physique*, XV.

smell and action upon turmeric paper; the odour of prussic acid may also be distinctly perceived; an oily matter smelling like naphtha, distils into the cool part of the tube in which the experiment is made, and a very abundant carbonaceous residue remains.

The most remarkable circumstance attending this decomposition of cinchonia, is the entire absence of all appearance of aqueous vapour, of which I have never been able to distinguish any traces, provided care had been taken to exclude air, even when the products were made to pass through a considerable extent of cooled tube. This led me to suspect the entire absence of oxygen in this substance, an opinion which was corroborated by its total want of action upon potassium, when heated with that metal in naphtha: the cinchonia, under these circumstances, readily dissolves in boiling naphtha, and again entirely separates as the solution cools, concreting into a radiated crystallized mass, in which the brilliant globules of potassium are disseminated.

The singular and characteristic properties of these vegetable alkalies, induced me to pay more attention to their ultimate analysis, and to endeavour to attain more accurate information respecting the nature and proportions of their elements, especially as cinchonia is stated, by its discoverers, to consist of oxygen, hydrogen, and carbon, and to be deficient in nitrogen*; a statement at which I am the more surprised, since a repetition of their principal experiments upon these bodies, has convinced me of the extreme accuracy of their difficult researches. In these experiments, which are always tedious and difficult, I have availed myself of the forms of apparatus contrived by Dr. Prout and Mr. Cooper, (*Henry's Elements*, ii. 165,) employing the peroxide of copper as originally recommended by M. Gay-Lussac, (*Ann. de Chimie*, xcvi. 53,) with the precautions suggested by Dr. Ure, in his valuable paper on the ultimate analysis of organic substances published in the *Philosophical Transactions* for 1822.

* *Annales de Chimie et Physique*, XV. 296.

From an experiment made with Dr. Prout's apparatus the relative proportions of carbon, nitrogen, and hydrogen, in cinchonia were estimated as follows :

Carbon	80.20
Nitrogen	12.85
Hydrogen	6.85
	99.90

In this analysis the permanently gaseous products were collected at one operation, and the hydrogen was estimated by a second experiment in which every product was allowed to escape from the tube, and the weight of carbonic acid and nitrogen then deducted from the entire loss.

In a second experiment, in which Mr. Cooper's apparatus was employed and in which, as in the others, he was good enough to assist me, similar proportions of cinchonia and of oxide of copper, were employed, but the water produced was retained in a portion of the tube, cooled for the purpose, and its quantity ascertained afterwards, by carefully weighing the tube, first in its original state, and a second time after the entire expulsion of the water by heat. The following is the result of this experiment :

Carbon	78.4
Nitrogen	14.6
Hydrogen	7.5
	100.5

Several other experiments were made chiefly with a view of detecting the presence of oxygen, but that element was in no instance discovered, either by any loss of weight, as indicated by the results of destructive distillation, or indirectly, by the appearance of aqueous vapour in other processes of decomposition. Among the latter, the effect of chlorine upon cinchonia may perhaps be regarded as most satisfactory. Five grains of carefully dried cinchonia, were introduced into a small exhausted retort which was afterwards filled with chlorine. There was no absorption of the gas, nor the smallest apparent action until very consider-

able heat was applied; the substance then blackened and was evidently decomposed, and upon examining the retort when cool, it was found to contain muriatic acid, but there was no appearance of condensed aqueous vapour in any part of it.

Quinia as has already been stated agrees with *cinchonia* in affording a large quantity of ammonia, when subjected to destructive distillation, and consequently, in containing nitrogen as one of its elements.

Having, as I conceive, satisfactorily established the non-existence of oxygen in *cinchonia*, I was induced to infer from analogy, that that element would not be found in *quinia*, and this opinion seemed justified by the apparent absence of aqueous vapour in the tubes in which it had been decomposed. But on passing the products of its decomposition through a long glass tube, containing fragments of rock crystal, and heated to bright redness, there appeared some slight traces of aqueous vapour in a portion of the tube cooled for the purpose of its condensation.

In the experiments made with a view of determining the ultimate components of *quinia*, there was also always a small loss of weight, which, from the above statement, may be referred to oxygen; but in five experiments very carefully repeated upon that substance, there were slight discrepancies of results, which induce me to give the following as, probably, an approximation only to the correct proportions of its elements.

Carbon		73.80
Nitrogen		13.00
Hydrogen		7.65
Oxygen		5.55
		100.

Morphia.—The results of three experiments made with a view to determine the ultimate composition of this substance, agree closely with each other; I have, therefore, no doubt of the accuracy of the following estimate of the relative proportions of its ultimate elements:—

Carbon	72.00
Nitrogen	5.50
Hydrogen	5.50
Oxygen	17.00
	100. *

When morphia is passed through a red-hot tube, it affords, as might be expected, a considerable portion of aqueous vapour, and when fused with potassium, or heated with it in naphtha, it manifests a very evident action upon that metal.

Strychnia.—The experiments which I have made upon this substance, induce me to regard it as resembling, in the nature of its ultimate elements, the preceding salifiable bases, but I have had no opportunity of ascertaining their relative proportions.

The strychnia which I examined, prepared by M. Robiquet, of Paris, was in small and imperfect octoëdral crystals; fusible as morphia, of a bitter taste, and intensely so when combined with an acid. Heated in a tube it decrepitates, fuses, becomes brown and black, ammonia and water being at the same time evolved. There can, therefore, be no doubt of the existence of carbon, nitrogen, hydrogen, and oxygen, in this substance.

It appears from the above experiments, that the peculiar salifiable bases, or alkaline substances, as they have been termed, separable from opium, from the varieties of cinchona, and from the *Nux Vomica*, resemble each other in containing nitrogen as a characteristic component part, and that consequently, when burned, they exhale an odour precisely resembling that of animal bodies, and like them afford ammonia, and some of its compounds, when subjected to distillation. There is another remarkable analogy which pervades this class of bodies, as far as they have hitherto

* M. Bussey, to whom we owe an analysis of morphia, gives the following as its components :—(*Annals of Philosophy*, vi. 229.)

Carbon	69.0
Nitrogen	4.5
Hydrogen	6.5
Oxygen	20.
	100

been examined, which is their very feeble saturating power in regard to the acids, or in other words, the high equivalent number by which they are represented.

In respect to cinchonia, 100 parts were found to require for saturation a quantity of diluted sulphuric acid, equivalent to 12.7 of real acid; of the sulphate of cinchonia thus obtained which crystallizes in quadrangular prisms without retaining water, 24 grains furnished by decomposition with muriate of baryta 8 grains of sulphate of baryta, equal to 2.72 sulphuric acid, so that upon these data the number 315 will be the prime equivalent of cinchonia, that of sulphuric acid being = 40. From the experiments of Messrs. Pelletier and Caventon, it appears that 100 parts of cinchonia saturate 13.02 of real sulphuric acid, proportions agreeing very nearly with those obtained in the laboratory of the Royal Institution, by Mr. Faraday.

Quinia saturates a still smaller quantity of the acids than cinchonia; by direct experiments, and by the analysis of the crystallized sulphate, 360 parts of quinia were found to neutralize 40 of real sulphuric acid.

The equivalent of morphia deduced from the experiments of MM. Pelletier and Caventou, (*Journal de Phar.*, v.) appears to be about 325, and that of strychnia 380. *Ann. de Chim. et Phys.* 155.)

These substances, therefore, arranged in the order of their saturating powers, stand in the following order, the annexed numbers being their prime equivalents in reference to hydrogen as unity.

Cinchonia	315
Morphia	325
Quinia	360
Strychnia	380

In detailing the above experiments, I have purposely avoided any allusion to the equivalent ratios in which the ultimate elements of the substances analyzed may be supposed to be associated, for I am not sufficiently convinced that the methods are susceptible of that extreme and rigorous accuracy which they should be, to serve as the foundations of so refined an application of the theory of proportionals.

It was my intention to have concluded this paper with some remarks upon the preparation of cinchonia and quinia, and upon the relative medical effects of these substances in their pure states and in the form of salts, but the experiments connected with these subjects not being yet complete, I shall reserve them for a future communication.

The cinchonia which I used in the above experiments, was prepared for me with much care, by Mr. Faraday, in the laboratory of the Royal Institution; and the quinia was made by Mr. Hennell, at Apothecaries' Hall, where considerable quantities of the sulphate of quinia have already been prepared for medical use. In the case of intermittent diseases the latter salt appears rising in reputation, and promises to come into as general use in this country as in France, where it is universally substituted for the bark in substance in cases of ague. Upon this subject some interesting details will be found, in a communication from Dr. Elliotson, to the Medico-Chirurgical Society, published in the twelfth volume of their *Transactions*.

ART. XIV. *Astronomical Phenomena arranged in order of Succession for the first Three Months of the Year 1824, computed for the Meridian and Parallel of Greenwich.*
By James South, Esq., F.R.S.

CONVINCED that next to the daily corrections in right ascension and north polar distance of the 46 principal stars*, there is nothing so much wanted in our observatories as an Astronomical Ephemeris, and regretting some one more adequate to the task has not yet undertaken it, I avail myself of Mr. Brande's kindness, which enables me through the medium of this Journal, to present the public with a list of astronomical phenomena, arranged in order of succession, for the first three months of the year 1824: computed for the Meridian and Parallel of Greenwich.

* In the *Annals of Philosophy* for the present month, I have published the daily corrections in right ascension of 37 Stars of the Greenwich catalogue.

Knowing that to the various forms of time, under which astronomical notices are given, we may attribute the loss of many a valuable observation, the phenomena here registered are reduced to sidereal time.

The Right Ascension and Declination of the Sun, Moon, Planets and Stars, are given to the nearest minute.

The Sun's place is taken from the *Nautical Almanac*.—The places of Mercury, Venus and the Georgian, are computed from data, found in the same work; those of Mars, Jupiter and Saturn, are taken from *Schumacher's Ephemeris*; whilst that of Juno is derived from tables published by Mr. Groombridge.

The right ascension of the Moon, is computed from the nautical, as is also her Declination, corrections for parallax and refraction having been applied to it; the ephemeris is continued as far through each lunation, as it is probable she will be observed.

The differential stars, and their places, are taken from *Schumacher's Astronomische Nachrichten*.

The eclipses of Jupiter's Satellites are computed from the *Nautical Almanac*, the corresponding mean time is also given; to the notice of each eclipse the distance of the planet from his opposition is annexed, so that by a reference to the diagrams published in this Journal, the observer will instantly be informed where the Immersion or Emersion will take place.—The time is accurate to the nearest minute.

The Occultations of Stars by the Moon, and the consequent Emersions, are derived from the list published in the *Philosophical Magazine*,—because, however, our clocks shew right ascensions in time, not in space, the degrees and minutes there given, are here converted into time—and as for the purpose of identifying a star, it is generally advisable, that its place should be brought up to the period of observation nearly; this I have also done;—and as apparent time in an observatory is useless, till converted into sidereal or mean, it is here altogether rejected, and the two latter are substituted in its stead,—the calculations are considered accurate, to two or three minutes of time.

For the original list, we are obliged to Messrs. Inghirami

and Baily, to the former for having made the calculations, to the latter for having published them ; and I trust neither the one, or the other, will feel displeasure because I have put them into a proper observatory dress.

That eclipses of stars of the 7th, 8th and 9th magnitudes may be observed I well know ; but it must be remembered that identification of the star, is as essential as the observation.—Now considering the frequency with which stars, such as these, are diffused over the heavens, the effect which the lunar light has apparently to alter their natural splendour, and to obliterate from our sight the presence of all minute stars, which under other circumstances might materially assist us, I fear little confidence must be placed in identifications, unless made by instrumental assistance*. He who has a telescope mounted equatorially, will do well to place it upon some known star in the neighbourhood of the Moon, and though it may not be accurately adjusted, it will afford him a result which when compared with the actual place of the star, may be applied in the form of index error, to the observed place of the unknown star ; hence a reference to the data furnished in this ephemeris, will generally inform him, how far his identification is complete.—Should the star be to the east of the meridian, he should endeavour, if possible, to get its transit over it the same evening, if to the west of it, he should procure it the first opportunity.

That the following pages are exempt from error, I dare not indulge the hope ; I believe, however, they will be found generally accurate ; the *practical* astronomer who knows what it is to observe all night, and to compute nearly all day, will I am sure pardon what is done amiss :—

* Gentlemen by their fire-sides, identify stars, however near to the Moon, easily enough ; but Major Kater (on shore,) who has had no little experience in these matters, assures me, that it was not without considerable difficulty, he could identify π Scorpii ; now this star is of the 3rd or 4th magnitude.—Again, Sir Thos. Brisbane and Mr. Rumker (at sea), transmitted to Europe, not long since, a novel observation, in the shape of an occultation of Mercury by the Moon, little suspecting that their *planet* Mercury was no other than the Star Regulus.

ASTRONOMICAL PHENOMENA arranged in Order of Succession,
for the first Three Months of the Year 1824.

JANUARY.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M. D. M.					H. M. D. M.	
1	Sun		18 44 23 5 S		41	Piscium	5.6	0 12 7 13 N	
	Mercury . .		19 34 23 53 S		45		6	0 17 6 43 N	
	Saturn . .		3 2 14 47 N		Moon . . .			0 22 7 20 N	
	Jupiter . .		6 24 23 17 N		o 135 . . .	8		0 30 6 57 N	
	Venus . .		15 31 15 54 S		Saturn . .			3 1 14 46 N	
2	Sun		18 48 23 0 S		Jupiter . .			6 20 23 20 N	
	Mercury . .		19 41 23 31 S		Im. * . . .	7		7 30 or 11 ^h 53 ^m MT.	
	Saturn . .		3 2 14 46 N		*'s R.A. 0 ^h 32'			Decl. 8° 24' N. (cont.)	
	Jupiter . .		6 24 23 17 N		Venus . .			16 3 17 40 S	
	Venus . .		15 36 16 9 S		9	Sun		19 19 22 13 S	
3	Sun		18 53 22 54 S		Mercury . .			20 28 20 54 S	
	Mercury . .		19 47 23 16 S		72	Piscium	6	0 56 14 0 N	
	Saturn . .		3 2 14 46 N		o 311 . . .	6		1 1 14 44 N	
	Jupiter . .		6 23 23 18 N		Moon . . .			1 10 12 34 N	
	Venus . .		15 40 16 25 S		101	Pisces	6	1 26 13 46 N	
4	Sun		18 57 22 49 S		Saturn . .			3 1 14 45 N	
	Mercury . .		19 54 22 57 S		Jupiter . .			6 20 23 21 N	
	Im. * . . .	7	2 41 or 7 ^h 48 ^m MT.		Venus . .			16 7 17 54 S	
	*'s R.A. 21 ^h 28'		Decl. 12° 14' S. (14' N.)		10	Sun		19 24 22 5 S	
	Saturn . .		3 1 14 46 N		Mercury . .			20 34 20 27 S	
	Em. * . .		3 30 or 8 ^h 9 ^m MT. (10' N.)		I. 243 . . .	6		1 54 17 24 N	
	Jupiter . .		6 22 23 18 N		I. 257 . . .	8		1 58 17 11 N	
	Em. 1 Sat.		9 40 or 14 ^h 46 ^m MT. (7)		Moon . . .			2 2 17 18 N	
	Venus . .		15 45 16 40 S		θ	Arietis	7.8	2 9 18 53 N	
5	Sun		19 2 22 42 S		Saturn . .			3 1 14 45 N	
	Mercury . .		20 1 22 34 S		Jupiter . .			6 19 23 21 N	
	Im. * . . .	4.5	22 46 or 3 ^h 49 ^m MT.		Venus . .			16 12 18 8 S	
	*'s R.A. 22 ^h 8'		Decl. 8° 39' S. (6' S.)		11	Sun		19 28 21 56 S	
	Em. * . .		23 26 or 4 ^h 29 ^m MT. (4' S.)		Mercury . .			20 40 19 56 S	
	Saturn . .		3 1 14 46 N		Im. * 1 . .	7.8		23 43 or 4 ^h 22 ^m MT.	
	Jupiter . .		6 22 23 19 N		*'s R.A. 2 ^h 54'			Decl. 20° 47' N. (0')	
	Venus . .		15 49 16 55 S		Em. * 1 . .			0 43 or 5 ^h 22 ^m MT. (9' S.)	
6	Sun		19 6 22 36 S		ε	Arietis	5	2 49 20 38 N	
	Mercury . .		20 8 22 11 S		Moon . . .			2 59 21 17 N	
	Saturn . .		3 1 14 46 N		Saturn . .			3 1 14 45 N	
	Em. 1 Sat.		4 16 or 9 ^h 14 ^m MT. (9)		τ	Arietis	6	3 11 20 30 N	
	Jupiter . .		6 21 23 19 N		66	6.7		3 18 22 12 N	
	Em. 2 Sat.		9 14 or 14 ^h 12 ^m MT. (9)		Im. * 2 . .	7		3 20 or 7 ^h 59 ^m MT.	
	Venus . .		15 54 17 11 S		*'s R.A. 3 ^h 0'			Decl. 21° 5' N. (cont.)	
7	Sun		19 10 22 29 S		Im. * 3 . .	7		3 21 or 8 ^h 0 ^m MT.	
	Mercury . .		20 15 21 48 S		*'s R.A. 3 ^h 1'			Decl. 21° 13' N. (7' S.)	
	16	Piscium	6	23 27 1 8 N		Em. * 3 . .		3 43 or 8 ^h 22 ^m MT. (13' S.)	
	17	Piscium	4.5	23 31 4 41 N		Im. * 4 . .	7	3 43 or 8 ^h 22 ^m MT.	
	Moon . . .		23 35 1 55 N		*'s R.A. 3 ^h 1'			Decl. 21° 30' N. (7' N.)	
	22	Piscium	6	23 43 1 57 N		Em. * 4 . .		4 50 or 9 ^h 29 ^m MT. (0')	
	Im. * . . .	6	1 10 or 6 ^h 5 ^m MT.		Jupiter . .			6 18 23 21 N	
	*'s R.A. 23 ^h 37'		Decl. 2° 28' N. (14' N.)		Em. 1 Sat.			12 30 or 16 ^h 40 ^m MT. (14)	
	Em. * . .		2 7 or 7 ^h 1 ^m MT. (1' N.)		Venus . .			16 17 18 21 S	
	Saturn . .		3 1 14 46 N		12	Sun		19 32 21 46 S	
	Jupiter . .		6 21 23 20 N		Mercury . .			20 46 19 26 S	
	Venus . .		15 58 17 26 S		Im. * . . .	6.7		23 53 or 4 28 MT.	
8	Sun		19 15 22 21 S		*'s R.A. 3 ^h 55'			Decl. 21° 32' N. (2' N.)	
	Mercury . .		20 21 21 21 S						

JANUARY.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M. D. M.					H. M. D. M.	
	Im. 3 Sat.		0 43 or 5 ^h 19' MT. (15)		VII. 57 . . .	3.4	7 10 22 18 N		
	Em. * . .		0 52 or 5 ^h 27' MT. (2's.)		VII. 97 . . .	7.8	7 16 21 53 N		
	Saturn . .		3 1 14 46 N		Moon . . .		7 24 21 31 N		
	III. 179 . .	7.8	3 42 24 38 N		VII. 179 . .	7	7 33 22 48 N		
	Em. 3 Sat.		3 51 or 8 ^h 26' MT. (15')		Im. 4 Sat.		9 33 or 13 ^h 55' MT. (18)		
	36 Tauri . .	6.7	3 54 23 37 N		Em. of it . .		11 22 or 15 ^h 44' MT. (18)		
	Moon . . .		4 1 24 3 N		Im. * 4 . .		11 59 or 16 ^h 21' MT.		
	↓ Tauri . .	6	4 12 25 12 N		*'s R.A. 7 ^h 35'		Decl. 20° 44' N. (6' N.)		
	Jupiter . .		6 18 23 22 N		Em. * 4 . .		12 38 or 17 ^h 0' MT. (11' N.)		
	Venus . .		16 21 18 35 S		Moon . . .		15 7 eclipsed.		
13	Sun . . .		19 37 21 37 S		Venus . .		16 36 19 13 S		
	Mercury . .		20 52 18 55 S		16 Sun . . .		19 49 21 5 S		
	Mars and γ Virg. dif. lat. 9'				Mercury . .		21 7 17 18 S		
	Saturn . .		3 1 14 46 N		Saturn . .		3 1 14 46 N		
	* Tauri . .	6	4 47 24 46 N		Jupiter . .		6 16 23 23 N		
	IV. 287 . .	8	4 55 26 11 N		25 Canc. . .	6	8 16 17 37 N		
	Moon . . .		5 7 25 11 N		θ	5.6	8 22 18 41 N		
	118 Tauri .	7	5 18 25 0 N		Moon . . .		8 29 16 57 N		
	Jupiter . .		6 17 23 22 N		52 Canc. . .	7.8	8 41 16 39 N		
	Em. 1 Sat.		6 38 or 11 ^h 9' MT. (16)		Venus . .		16 41 19 25 S		
	Im. * . . .	7	9 46 or 14 ^h 16' MT.		17 Sun . . .		19 54 20 54 S		
	*'s R.A. 5 ^h 18'		Decl. 25° 0' N. (5' S.)		Mercury . .		21 11 16 46 S		
	Em. * . .		10 35 or 15 ^h 5' MT. (1's.)		Em. 2 Sat.		1 53 or 6 ^h 8' MT. (20)		
	Em. 2 Sat.		12 20 or 16 ^h 49' MT. (16)		Saturn . .		2 1 14 46 N		
	Venus . .		16 26 18 49 S		Im. * 1 . .	5	4 47 or 9 ^h 2' MT.		
14	Sun . . .		19 41 21 26 S		*'s R.A. 9 ^h 22'		Decl. 12° 5' N. (7' S.)		
	Mercury . .		20 57 18 23 S		Em. * 1 . .		5 45 or 10 ^h 0' MT. (7' N.)		
	Im. * 1 . .	7	23 16 or 3 ^h 44' MT.		Jupiter . .		6 15 23 23 N		
	*'s R.A. 6 ^h 1'		Decl. 24° 27' N. (1' N.)		Im. * 2 . .	7	8 11 or 12 ^h 25' MT.		
	Em. * 1 . .		0 3 or 4 ^h 30' MT. (0')		*'s R.A. 9 ^h 29'		Decl. 11° 34' N. (13' N.)		
	Saturn . .		3 1 14 46 N		Em. * 2 . .		8 26 or 12 ^h 40' MT. (16' N.)		
	5 Gem. . .	7	6 1 24 27 N		IX. 35 . . .	7	9 8 12 14 N		
	8	7	6 6 24 1 N		Leonis . .	5	9 22 12 5 N		
	Moon . . .		6 16 24 21 N		Moon . . .		9 30 11 12 N		
	Jupiter . .		6 17 23 22 N		19 Leonis .	7	9 38 12 23 N		
	VI. 166 . .	7.8	6 27 24 44 N		Im. * 3 . .	4	10 12 or 14 ^h 26' MT.		
	Moon . . .		6 30 with Jupiter.		*'s R.A. 9 ^h 32'		Decl. 10° 41' N. (16' S.)		
	Im. * 2 . .	7	11 7 or 15 ^h 33' MT.		Em. * 3 . .		10 37 or 14 ^h 51' MT. (4' S.)		
	*'s R.A. 6 ^h 27'		Decl. 23° 39' N. (15' S.)		Venus . .		16 45 19 36 S		
	Em. * 2 . .		11 42 or 16 ^h 8' MT. (1' N.)		18 Sun . . .		19 58 20 42 S		
	Venus . .		16 31 19 1 S		Mercury . .		21 14 16 15 S		
15	Sun . . .		19 45 21 16 S		Im. * 1 . .	6	2 53 or 7 ^h 5' MT.		
	Mercury . .		21 2 17 50 S		*'s R.A. 10 ^h 14'		Decl. 6° 35' N. (1' N.)		
	Im. * 1 . .	3.4	0 37 or 5 ^h 1' MT.		Saturn . .		3 1 14 47 N		
	*'s R.A. 7 ^h 10'		Decl. 22° 18' N. (9' N.)		Em. * 1 . .		3 38 or 7 ^h 50' MT. (12' N.)		
	Em. 1 Sat.		1 14 or 5 ^h 37' MT. (18)		Jupiter . .		6 15 23 24		
	Em. * 1 . .		1 14 or 5 ^h 38' MT. (12' N.)		Im. * 2 . .		7 8 or 11 ^h 19' MT.		
	Saturn . .		3 1 14 46 N		*'s R.A. 10 ^h 23'		Decl. 5° 33' N. (0)		
	Im. * 2 . .	7.8	3 14 or 7 ^h 38' MT.		Em. * 2 . .		8 4 or 12 ^h 15' MT. (14' N.)		
	*'s R.A. 7 ^h 16'		Decl. 21° 53' N. 4' N.)		Moon . . .		10 27 4 46 N		
	Im. * 3 . .	6	3 38 or 8 ^h 2' MT.		Im. * 3 . .	6	14 47 or 18 ^h 57' MT.		
	*'s R.A. 7 ^h 17'		Decl. 21° 48' N. (7' N.)		*'s R.A. 10 ^h 36'		Decl. 3° 15' N. (6' S.)		
	Em. * 2 . .		4 12 or 8 ^h 35' MT. (1' N.)		Em. * 3 . .		15 44 or 19 ^h 54' MT. (9' N.)		
	Em. * 3 . .		4 35 or 8 ^h 58' MT. (2' S.)		Venus . .		16 50 19 48 S		
	Jupiter . .		6 16 23 23 N		19 Sun . . .		20 2 20 30 S		

JANUARY.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M. D. M.					H. M. D. M.	
	Mercury .		21 18 15 43 S (Gr.El.)			*s R.A. 15 ^h 44' Decl. 24° 43' S. (6'S.)			
	Saturn . .		3 1 14 47 N			Em. * 1 .		12 20 or 16 ^h 6' MT. (7's.)	
	Im. 3 Sat.		5 11 or 9 ^h 18' MT. (22)			Em. * 2 .		12 54 or 16 ^h 40' MT. (1's.)	
	Jupiter . .		6 14 23 24 N			Em. * 3 .		13 1 or 16 ^h 47' MT. (2'N.)	
	Em. 3 Sat.		8 19 or 12 ^h 26' MT. (22)			Venus . .		17 19 20 42	
	Venus . .		16 55 20 0 S		25	Sun		20 28 19 9 S	
20	Sun		20 7 20 17 S			Mercury .		21 26 13 22	
	Mercury .		21 20 15 15 S			Saturn . .		3 1 14 49 N	
	Saturn . .		3 1 14 47 N			Jupiter . .		6 12 23 26 N	
	Jupiter . .		6 14 23 24 N			Im * . . . 7.8		13 18 or 17 ^h 1' MT.	
	Em. 1 Sat.		9 1 or 13 ^h 3' MT. (23)			*s R.A. 16 ^h 39' Decl. 26° 18' S. (cont.)			
	Venus . .		17 0 20 8 S			Venus . .		17 24 20 50 S	
21	Sun		20 11 20 4 S		26	Sun		20 32 18 54 S	
	Mercury .		21 23 14 48 S			Mercury .		21 24 13 12 S	
	Saturn . .		3 1 14 47 N			Saturn . .		3 1 14 50 N	
	Jupiter . .		6 13 23 25 N			Jupiter . .		6 11 23 26 N	
	Venus . .		17 5 20 17 S			Im. 3 Sat.		9 40 or 13 ^h 19' MT. (29)	
22	Sun		20 15 19 51 S			Em. 3 Sat.		12 49 or 16 ^h 27' MT. (29)	
	Mercury .		21 25 14 21 S			Venus . .		17 29 20 55 S	
	Saturn . .		3 1 14 48 N		27	Sun		20 36 18 39 S	
	Em. 1 Sat.		3 36 or 7 ^h 32' MT. (25)			Mercury .		21 22 13 2 S	
	Jupiter . .		6 13 23 25 N			Saturn . .		3 1 14 50 N	
	Im. * 1 . . 9		11 46 or 15 ^h 40' MT.			Jupiter . .		6 11 23 26 N	
	*s R.A. 13 ^h 57' Decl. 18° 26' S. (16'S.)					Em. 1 Sat.		11 23 or 14 ^h 58' MT. (30)	
	Em. * 1 .		12 3 or 15 ^h 57' MT. (7's.)			Venus . .		17 34 21 1 S	
	Im. * 2 . .		12 24 or 16 ^h 18' MT.		28	Sun		20 40 18 23 S	
	*s R.A. 13 ^h 59' Decl. 18° 24' S. (5'S.)					Mercury .		21 20 12 53 S	
	Em. * 2 .		13 36 or 17 ^h 30' MT. (9'N.)			Saturn . .		3 1 14 51 N	
	Venus . .		17 10 20 25 S			Jupiter . .		6 10 23 27 N	
23	Sun		20 19 19 37 S			Im. * . . . 7.8		15 26 or 18 56 MT.	
	Mercury .		21 25 14 1 S			*s R.A. 19 ^h 22' Decl. 23° 6' S. (3'N.)			
	Saturn . .		3 1 14 48 N			Em. * . .		16 30 or 20 ^h 0' MT. (7'N.)	
	Jupiter . .		6 12 23 25 N			Venus . .		17 39 21 6 S	
	Im. * 1 . . 7.8		10 37 or 14 ^h 27' MT.		29	Sun		20 44 18 8 S	
	*s R.A. 14 ^h 49' Decl. 21° 41' S. (1'N.)					Mercury .		21 16 12 56 S	
	Em. * 1 .		11 30 or 15 ^h 20' MT. (12'N.)			Saturn . .		3 1 14 51 N	
	Im. * 2 . . 7		14 31 or 18 ^h 21' MT.			Em. 1 Sat.		5 59 or 9 ^h 27' MT. (32)	
	*s R.A. 14 ^h 55' Decl. 22° 19' S. (3'N.)					Jupiter . .		6 10 23 27 N	
	Im. * 3 . . 7		15 12 or 19 ^h 2' MT.			Im * . . . 5.6		15 36 or 19 ^h 2' MT.	
	*s R.A. 14 ^h 56' Decl. 22° 38' S. (9'N.)					*s R.A. 20 ^h 9' Decl. 19° 40' S. (cont.)			
	Em. * 2 .		15 50 or 19 ^h 40' MT. (12'N.)			Venus . .		17 44 21 11 S	
	Em. * 3 .		16 22 or 20 ^h 12' MT. (1's.)		30	Sun		20 48 17 51 S	
	Venus . .		17 14 20 33 S			Mercury .		21 13 12 58 S	
24	Sun		20 23 19 23 S			Saturn . .		3 1 14 52 N	
	Mercury .		21 26 13 42 S			Jupiter . .		6 10 23 27 N	
	Saturn . .		3 1 14 49 N			Venus . .		17 49 21 16 N	
	Em. 2 Sat.		4 58 or 8 ^h 46' MT. (27)		31	Sun		20 52 17 35 S	
	Jupiter . .		6 12 23 26 N			Mercury .		21 9 13 1 S	
	Im. * 1 . . 5		11 34 or 15 ^h 20' MT.			Saturn . .		3 1 14 53 N	
	*s R.A. 15 ^h 43' Decl. 24° 48' S. (14'S.)					Jupiter . .		6 9 23 27 N	
	Im. * 2 . . 6		11 49 or 15 ^h 35' MT.			Em. 2 Sat.		8 4 or 11 ^h 23' MT. (34)	
	*s R.A. 15 ^h 44' Decl. 24° 43' S. (7'N.)					Venus . .		17 54 21 22 S	
	Im. * 3 . . 6		11 55 or 15 ^h 41' MT.						

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Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M. D. M.					H. M. D. M.	
1	Sun		20 57 17 18 S		II. 261 . . .	7	2 59 20 5 N		
	Mercury . .		21 5 13 10 S		Saturn . . .		3 2 14 58 N		
	Jupiter and 11 Gemini, dif. lat. 3'				Jupiter . . .		6 7 23 29 N		
	Saturn . . .		3 1 or 14 53 N		Im. *	5	9 0 or 11 51' MT.		
	Im. 4 Sat.		4 39 or 7 ^h 55' MT. (35)		*'s R.A. 2 ^h 49'		Decl. 20° 38' N. (8'N.)		
	Jupiter . . .		6 9 23 27 N		Em.		9 57 or 12 ^h 48' MT. (5'N.)		
	Em. 4 Sat.		6 44 10 ^h 0' MT. (35)		Em. 2 Sat.		11 9 14 ^h 1' MT. (11)		
	Mars		12 50 2 4 S		Mars		12 53 2 16 S		
	Venus . . .		17 59 21 27 S		Venus		18 29 21 38 S		
2	Sun		21 1 17 1 S		Mercury . . .		20 35 15 9 S		
	Saturn . . .		3 1 14 54 N		8 Sun		21 25 15 13 S		
	Jupiter . . .		6 9 23 28 N		Saturn		3 2 14 59 N		
	Mars		12 50 2 7 S		7 Tauri . . .	6	3 24 23 52 N		
	Venus . . .		18 4 21 29 S		Moon		3 34 22 57 N		
	Mercury . .		20 55 13 42 S (Inf. C.)		III. 172 . . .	7.8	3 40 23 25 N		
3	Sun		21 5 16 44 S		33 Tauri . . .	6.7	3 47 22 39 N		
	Im. *	9	2 42 or 5 ^h 50' MT.		Im. * 1 . . .	5	4 51 or 7 ^h 40' MT.		
	*'s R.A. 23 ^h 25'		Decl. 1° 2' N. (13'N.)		*'s R.A. 3 ^h 36'		Decl. 23° 24' N. (cont.)		
	Saturn . . .		3 1 14 55 N		Im. * 2 . . .	7.8	5 43 or 8 ^h 32' MT.		
	Em. * . . .		3 40 or 6 ^h 48' MT. (0')		*'s R.A. 3 ^h 38'		Decl. 23° 19' N. (10'S.)		
	Im. *	6	3 53 7 ^h 1' MT.		Im. * 3 . . .	8.9	5 55 or 8 ^h 44' MT.		
	*'s R.A. 23 ^h 27'		Decl. 1° 8' N. (10'N.)		*'s R.A. 3 ^h 39'		Decl. 23° 21' N. (11'N.)		
	Em.		4 12 or 7 ^h 20' MT. (14'S.)		Im. * 4 . . .		6 2 or 8 ^h 51' MT.		
	Jupiter . . .		6 8 23 28 N		*'s R.A. 3 ^h 39'		Decl. 23° 10' N. (0')		
	Mars		12 51 2 9 S		Jupiter . . .		6 7 23 29 N		
	Venus . . .		18 9 21 31 S		Im. * 5 . . .	8	6 10 or 8 ^h 59' MT.		
	Mercury . .		20 51 13 58 S		*'s R.A. 3 ^h 40'		Decl. 23° 18' N. (7'S.)		
4	Sun		21 9 16 26 S		Im. * 6 . . .	5	6 17 or 9 ^h 6' MT.		
	Saturn . . .		3 2 14 56 N		*'s R.A. 3 ^h 39'		Decl. 23° 30' N. (cont.)		
	Jupiter . . .		6 8 23 28 N		Em. * 2 . . .		6 38 or 9 ^h 27' MT. (6'S.)		
	Im. *	6	6 40 or 9 ^h 44' MT.		Em. * 3 . . .		6 47 or 9 ^h 36' MT. (8'S.)		
	*'s R.A. 0 ^h 17'		Decl. 6° 43' N. (7'S.)		Im. * 7 . . .	7.8	6 48 or 9 ^h 37' MT.		
	Em.		7 14 or 10 ^h 18' MT. (14'S.)		*'s R.A. 3 ^h 40'		Decl. 23° 25' N. (12'N.)		
	Mars		12 51 2 11 S		Em. * 4 . . .		7 3 or 9 ^h 52' MT. (4'S.)		
	Venus . . .		18 14 21 33 S		Em. * 5 . . .		7 10 or 9 ^h 59' MT. (4'S.)		
	Mercury . .		20 46 14 14 S		Em. * 7 . . .		7 31 or 10 ^h 20' MT. (9'S.)		
5	Sun		21 13 16 8 S		Im. * 8 . . .	7	10 10 or 12 ^h 58' MT. (13'S.)		
	Saturn . . .		3 2 14 56 N		*'s R.A. 3 ^h 48'		Decl. 23° 24' N		
	Jupiter . . .		6 8 23 28 N		Em. * 8 . . .		10 39 or 13 ^h 27' MT. (13'S.)		
	Em. 1 Sat.		8 22 or 11 ^h 22' MT. (39)		Mars		12 53 2 17 S		
	Mars		12 52 2 13 S		Venus		18 34 21 36 S		
	Venus . . .		18 19 21 34 S		9 Mercury . .		20 32 15 27 S		
	Mercury . .		20 42 14 32 S		Sun		21 29 14 51 S		
6	Sun		21 17 15 50 S		Saturn		3 2 15 0 N		
	Moon		1 42 15 34 N		Moon		4 36 24 47 N		
	Saturn . . .		3 2 14 57 N		98 Tauri . . .	6	4 47 24 46 N		
	Jupiter . . .		6 7 23 28 N		IV. 287 . . .	8	4 55 26 11 N		
	Mars		12 52 2 14 S		IV. 295 . . .	6	4 57 24 1 N		
	Venus . . .		18 21 21 36 S		Jupiter . . .		6 7 23 29 N		
	Mercury . .		20 39 14 51 S		Im. *	7	7 46 or 10 ^h 31' MT.		
7	Sun		21 21 15 32 N		*'s R.A. 4 ^h 43'		Decl. 25° 4' N. (12'N.)		
	♈ Arietis . .	5.6	2 29 21 12 N		Em.		8 18 or 11 ^h 2' MT. (13'S.)		
	Moon		2 37 19 46 N		Im. *	6	9 35 or 12 ^h 19' MT.		
	47 Arietis .	6	2 48 19 57 N		*'s R.A. 4 ^h 47'		Decl. 24° 46' N. (4'S.)		
	Em. 1 Sat.		2 58 or 5 ^h 51' MT. (41)		Em.		10 30 or 13 ^h 14' MT. (2'S.)		
					Mars		12 53 2 18 S		

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			H. M.	D. M.				H. M.	D. M.
10	Venus . .		18 39	21 34 S		Em. . . .		7 43 or 10 ^h 12 ^m MT. (8's.)	
	Mercury .		20 29	15 44 S		VIII. 208. . 8	8 46	14 51 N	
	Sun		21 33	14 35 S		VIII. 225. . 8	8 50	13 45 N	
	Saturn . .		3 2	15 1 N		Moon . . .		8 56	14 31 N
	125 Tauri. . 6		5 29	25 47 N		π Cancri . . 6.7	9 3	15 42 N	
	V. 214 . . . 7.8		5 37	24 37 N		Mars . . .		12 54	2 18 S
	Moon . . .		5 41	24 56 N		Stationary near λ Virginis.			
	139 Tauri. . 5.6		5 47	25 55 N		Im. * 8	14 45 or 17 ^h 13 ^m MT.		
	Jupiter . .		6 6	23 29 N		*'s R.A. 9 ^h 9'	Decl. 13° 3' N. (4'S.)		
	Im. * 8		8 30	or 11 ^h 10 ^m MT.		Em.	15 24 or 17 ^h 52 ^m MT. (14's.)		
	*'s R.A. 5 ^h 48'		Decl. 21° 34' N. (13'S.)			Venus . . .	19 0	21 26 S	
	Em.		9 9 or 11 ^h 49 ^m MT. (10's.)			Mercury . .	20 24	16 47 S	
	Mars . . .		12 54	2 18 S	14	Sun	21 48	13 16 S	
	Im. * 7		13 39 or 16 ^h 19 ^m MT.			Saturn . . .	3 3	15 5 N	
	*'s R.A. 6 ^h 1'		Decl. 24° 27' N. (13'N.)			Im. * 6	4 31 or 6 ^h 56 ^m MT.		
	Em.		14 0 or 16 ^h 40 ^m MT. (15'N.)			*'s R.A. 9 ^h 47'	Decl. 9° 46' N. (10'S.)		
	Venus . . .		18 44	21 32 S		Em.	4 46 or 7 ^h 11 ^m MT. (16's.)		
	Mercury . .		20 26	16 2 S		Em. 1 Sat. .	5 21 or 7 ^h 46 ^m MT. (48)		
11	Sun		21 37	14 15 S		Im. * 6	5 30 or 7 ^h 55 ^m MT.		
	Saturn . . .		3 3	15 2 N		*'s R.A. 9 ^h 49'	Decl. 9° 9' N. (15'N.)		
	Jupiter . .		6 6	23 29 N		Jupiter . . .	6 6	23 30 N	
	Moon . . .		6 48	23 11 N		Em. *	6 13 or 8 ^h 38 ^m MT. (5'N)		
	44 Gem. . . 6.7		6 55	22 54 N		Im. * 4.5	6 36 or 9 ^h 1 ^m MT.		
	48 Gem. . . 6		7 2	24 25 N		*'s R.A. 9 ^h 51'	Decl. 8° 53' N. (15'N.)		
	58 Gem. . .		7 13	23 17 N		Em.	7 22 or 9 ^h 47 ^m MT. (5s.)		
	Im. * 6.7		9 32 or 12 ^h 8 ^m MT.			IX. 202. . . 8	9 45	8 54 N	
	*'s R.A. 6 ^h 53'		Decl. 22° 54' N. (4'N.)			11 Sext. . . 6	9 49	9 9 N	
	Em.		10 25 or 13 ^h 1 ^m MT. (9's.)			Moon	9 56	8 23 N	
	Mars . . .		12 54	2 18 S		X. 51 7.8	10 13	9 51 N	
	Venus . . .		18 50	21 30 S		Mars	12 54	2 18 S	
	Mercury . .		20 25	16 17 S		Venus	19 5	21 20 S	
12	Sun		21 41	13 56 S		Mercury . .	20 24	16 58 S	
	Saturn . . .		3 3	15 3 N	15	Sun	21 52	12 55 S	
	Im. * 6.7		3 20 or 5 ^h 53 ^m MT.			Saturn . . .	3 3	15 6 N	
	*'s R.A. 7 ^h 45'		Decl. 26° 20' N. (6'N.)			Im. * 7	4 59 or 7 ^h 20 ^m MT.		
	Em.		4 9 or 6 ^h 42 ^m MT. (12'N.)			*'s R.A. 10 ^h 44'	Decl. 3° 2' N. (10'S.)		
	Jupiter . .		6 6	23 29 N		Em.	5 54 or 8 ^h 15 ^m MT. (4'N.)		
	79 Gem. . . 7		7 35	20 44 N		Jupiter . . .	6 5	23 30 N	
	VII. 224 . . 7		7 42	19 46 N		Im. * 7	8 6 or 10 ^h 27 ^m MT.		
	85 Gem. . . 6.7		7 45	20 20 N		*'s R.A. 10 ^h 46'	Decl. 2° 41' N. (cont.)		
	Moon . . .		7 53	19 39 N		36 Sext. . . 6	10 36	3 15 N	
	Em. 1 Sat. .		10 45 or 13 ^h 17 ^m MT. (46)			55 Leonis. . 6	10 47	1 40 N	
	Mars		12 54	2 18 S		Moon	10 53	1 44 N	
	Im. * 7		13 14 or 15 ^h 46 ^m MT.			75 Leonis. . 5.6	11 8	2 59 N	
	*'s R.A. 8 ^h 4'		Decl. 18° 12' N. (cont.)			Mars	12 54	2 17 S	
	Im. * 8		13 44 or 16 ^h 16 ^m MT.			Venus	19 10	21 15 S	
	*'s R.A. 8 ^h 6'		Decl. 18° 5' N. (cont.)			Mercury . .	20 25	17 9 S	
	Venus . . .		18 55	21 28 S	16	Sun	21 56	12 35 S	
	Mercury . .		20 24	16 32 S		Saturn . . .	3 3	15 7 N	
13	Sun		21 45	13 36 S		Jupiter . . .	6 5	23 30 N	
	Saturn . . .		3 3	15 4 N		XI. 167. . . 6	11 42	4 21 S	
	Jupiter . .		6 6	23 30 N		XI. 168. . . 8	11 46	4 9 S	
	Im. * 8.9		6 40 or 9 ^h 9 ^m MT.			Moon	11 49	4 56 S	
	*'s R.A. 8 ^h 54'		Decl. 14° 52' N. (6'N.)			XI. 221. . . 7.8	11 55	4 30 S	

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			H. M. D. M.					H. M. D. M.	
17	Mars . . .		12 54 2 16 S		23	Mercury .		20 39 17 47 S	
	Venus . . .		19 15 21 9 S			Sun		22 23 10 6 S	
	Mercury .		20 25 17 20 S			Saturn . .		3 5 15 16 N	
	Sun		22 0 12 14 S			Jupiter . .		6 5 23 31 N	
	Saturn . .		3 4 15 8 N			Mars . . .		12 53 2 1 S	
	Jupiter . .		6 5 23 30 N			Im. * . . .	4	17 43 or 19 ^h 31' MT.	
	Mars . . .		12 54 2 15 S			*'s R.A. 18 ^h 17'		Decl. 25° 30' S. (48.)	
18	Venus . .		19 20 21 4 S		24	Em. . . .		19 9 or 20 ^h 56' MT. (0')	
	Mercury .		20 27 17 27 S			Venus . .		19 51 20 16 S	
	Sun		22 4 11 53 S			Mercury .		20 42 17 45 S	
	Saturn . .		3 4 15 8 N			Sun		22 27 9 44 S	
	Em. 2 Sat.		3 47 or 5 ^h 56' MT. (52)			Saturn . .		3 5 15 17 N	
	Jupiter . .		6 5 23 30			Jupiter . .		6 5 23 31 N	
	Im. * . . .	6.7	8 58 or 11 ^h 6' MT.			Em. 3 Sat.		6 43 or 8 ^h 29' MT. (58)	
19	*'s R.A. 13 ^h 31'		Decl. 15° 33' S. (1' N.)		25	Mars . . .		12 53 1 58 S	
	Em. . . .		9 28 or 11 ^h 36' MT. (8' N.)			Venus . .		19 56 20 7 S	
	Mars . . .		12 54 2 13 S			Mercury .		20 46 17 42 S	
	Venus . .		19 25 20 59 S			Sun		22 31 9 21 S	
	Mercury .		20 28 17 33 S			Saturn . .		3 6 15 18 N	
	Sun		22 8 11 32 S			Jupiter . .		6 5 23 31 N	
	Saturn . .		3 4 15 11 N			Em. 2 Sat.		6 52 or 8 ^h 33' MT. (59)	
20	Jupiter . .		6 5 23 30 N		26	Mars . . .		12 52 1 55 S	
	Mars . . .		12 54 2 11 S			Venus . .		20 1 19 58 S	
	Em. 1 Sat.		13 8 or 15 ^h 12' MT. (53)			Mercury .		20 49 17 40 S	
	Venus . .		19 30 20 53 S			Sun		22 35 8 59 S	
	Mercury .		20 30 17 40 S			Saturn . .		3 6 15 20 N	
	Sun		22 12 11 11 S			Jupiter . .		6 5 23 31 N	
	Saturn . .		3 4 15 12 N			Mars . . .		12 52 1 51 S	
21	Jupiter . .		6 5 23 31 N		27	Venus . .		20 6 19 46 S	
	Mars . . .		12 54 2 9 S			Mercury .		20 53 17 34 S	
	Venus . .		19 35 20 44 S			Sun		22 38 8 37 S	
	Mercury .		20 33 17 42 S			Saturn . .		3 6 15 21 N	
	Sun		22 16 10 49 S			Jupiter . .		6 5 23 31 N	
	Saturn . .		3 5 15 13 N			Mars . . .		12 51 1 47 S	
	Jupiter . .		6 5 23 31 N			Venus . .		20 11 19 33 S	
22	Em. 1 Sat.		7 44 or 9 ^h 41' MT. (55)		28	Mercury .		20 58 17 29 S	
	Mars . . .		12 54 2 7 S			Sun		22 42 8 14 S	
	Venus . .		19 40 20 35 S			Saturn . .		3 6 15 22 N	
	Mercury .		20 36 17 45 S			Jupiter . .		6 5 23 31 N	
	Sun		22 19 10 27 S			Em. 1 Sat.		10 7 or 11 ^h 36' MT. (62.)	
	Saturn . .		3 5 15 14 N			Mars . . .		12 51 1 43 S	
	Jupiter . .		6 5 23 31 N			Venus . .		20 16 19 21 S	
	Mars . . .		12 53 2 4 S		29	Mercury .		21 2 17 23 S (Gr. El.)	
	Im. * 1 . .	6.7	15 53 or 17 ^h 45' MT.			Sun		22 46 7 52 S	
	*'s R.A. 17 ^h 21'		Decl. 26° 7' S. (14' N.)			Saturn . .		3 7 15 24 N	
	Im. * 2 . .	7	16 9 or 18 ^h 1' MT.			Jupiter . .		6 5 23 32 N	
	*'s R.A. 17 ^h 21'		Decl. 26° 7' S. (14' N.)			Mars . . .		12 50 1 38 S	
	Em. * 2 . .		16 36 or 18 ^h 28' MT. (14' N.)			Venus . .		20 21 19 9 S	
	Em. * 1 . .		16 47 or 18 ^h 39' MT. (14' N.)			Mercury .		21 6 17 16 S	
	Venus . .		19 45 20 26 S						

MARCH.

Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M. D. M.					H. M. D. M.	
1	Sun		22 50 7 29 S		8	Mercury .		21 41 15 29 S	
	Im *	6.7	4 58 or 6 ^h 20 ^m MT.			Sun		23 16 4 47 S	
	*'s R.A. 23 ^h 14'		Decl. 0° 40' S. (cont.)			Im. * 1 . . .	7	4 17 or 5 ^h 12 ^m MT.	
	Jupiter . .		6 5 23 32 N			*'s R.A. 5 ^h 18'		Decl. 25° 0' N. (7'N.)	
	Mars		12 49 1 33 S			Moon		5 17 24 54 N	
	Venus . . .		20 26 18 56 S			V. 115 . . .	8	5 21 26 51 N	
	Mercury . .		21 10 17 3 S			Em. * 1 . . .		5 21 or 6 ^h 15 ^m MT. (6'N.)	
2	Sun		22 53 7 6 S			121 Tauri . .	6	5 25 23 55 N	
	Jupiter . .		6 5 23 32 N			125	6	5 29 25 47 N	
	Im. 3 Sat. .		8 0 or 9 ^h 18 ^m MT. (65)			Jupiter . . .		6 6 23 32 N	
	Em		11 13 or 12 ^h 30 ^m MT. (65)			Em. 1 Sat. . .		7 6 or 8 ^h 0 ^m MT. (71)	
	Mars		12 48 1 28 S			Mars		12 43 0 53 S	
	Venus . . .		20 31 18 41 S			Im. * 2 . . .	7.8	12 49 or 13 ^h 42 ^m MT.	
	Mercury . .		21 15 16 49 S			*'s R.A. 5 ^h 37'		Decl. 24° 37' N. (10'N.)	
3	Sun		22 57 6 43 S			Im. * 3 . . .	5	13 18 or 14 ^h 11 ^m MT.	
	Jupiter . .		6 5 23 32 N			*'s R.A. 5 ^h 38'		Decl. 24° 30' N. (4'N.)	
	Em. 2 Sat. .		9 57 or 11 ^h 10 ^m MT. (66)			Em. * 2 . . .		13 29 or 14 ^h 22 ^m MT. (12'N.)	
	Mars		12 48 1 23 S			Em. * 3 . . .		13 57 or 14 ^h 50 ^m MT. (8'N.)	
	Venus . . .		20 36 18 25 S			Venus		21 1 17 6 S	
	Mercury . .		21 20 16 35 S			Mercury . . .		21 47 15 7 S	
4	Sun		23 1 6 20 S		9	Sun		23 19 4 23 S	
	Jupiter . .		6 5 23 32 N			Jupiter . . .		6 6 23 32 N	
	Mars		12 47 1 17 S			8 Gem. . . .	7	6 6 24 1 N	
	Venus . . .		20 41 18 10 S			VI. 67 . . .		6 11 23 50 N	
	Mercury . .		21 25 16 21 S			Moon		6 20 23 57 N	
5	Sun		23 4 5 57 S			V. 168 . . .	7.8	6 28 24 36 N	
	Jupiter . .		6 5 23 32 N			Im. * 1 . . .	7	7 51 or 8 ^h 41 ^m MT.	
	Im. * 1 . . .	7	7 18 or 8 ^h 24 ^m MT.			*'s R.A. 6 ^h 27'		Decl. 23° 39' N. (7' S.)	
	*'s R.A. 2 ^h 29'		Decl. 18° 58' N. (3'N.)			Em. * 1 . . .		8 56 or 9 ^h 46 ^m MT. (0')	
	Em. * 1 . . .		8 10 or 9 ^h 16 ^m MT. (9'N.)			Im. * 2 . . .	7	11 45 or 12 ^h 35 ^m MT.	
	Im. * 2 . . .	6	9 3 or 10 59 MT.			*'s R.A. 6 ^h 34'		Decl. 23° 0' N. (cont.)	
	*'s R.A. 2 ^h 28'		Decl. 19° 15' N. (3' S.)			Im. 3 Sat. . .		12 29 or 13 ^h 18 ^m MT. (72)	
	Em. * 2 . . .		9 53 or 10 ^h 59 ^m MT. (2'N.)			Im. * 3 . . .	7	12 36 or 13 ^h 26 ^m MT.	
	Mars		12 46 1 12 S.			*'s R.A. 6 ^h 36'		Decl. 23° 33' N. (cont.)	
	Venus . . .		20 46 17 55 S			Mars		12 42 0 47 S	
	Mercury . .		21 30 16 4 S			Venus		21 6 16 48 S	
6	Sun		23 8 5 34 S			Mercury . . .		21 52 14 46 S	
	Moon		3 15 21 51 N		10	Sun		23 23 4 0 S	
	Im. * 1 . . .	6.7	4 41 or 5 ^h 43 ^m MT.			Jupiter . . .		6 6 23 32 N	
	*'s R.A. 3 ^h 18'		Decl. 22° 12' N. (9' S.)			56 Gem. . .	5.6	7 12 20 46 N	
	Em. * 1 . . .		5 44 or 6 ^h 46 ^m MT. (3' S.)			VII. 97 . . .	7.8	7 16 21 53 N	
	Jupiter . .		6 5 23 32 N			Moon		7 24 21 17 N	
	Im. * 2 . . .	7	9 27 or 10 ^h 28 ^m MT.			79 Gem. . .	7	7 35 20 44 N	
	*'s R.A. 3 ^h 27'		Decl. 22° 38' N. (cont.)			Mars		12 41 0 40 S	
	Im. * 3 . . .	6.7	10 2 or 11 ^h 3 ^m MT.			Mars and χ Virg. dif. Lat. insensible			
	*'s R.A. 3 ^h 28'		Decl. 22° 5' N. (cont.)			Em. 2 Sat. . .		13 2 or 13 ^h 47 ^m MT. (73)	
	Em. 1 Sat. .		12 30 or 13 ^h 31 ^m MT. (69)			Im. *	7	14 57 15 ^h 42 ^m MT.	
	Mars		12 45 1 6 S			*'s R.A. 7 ^h 42'		Decl. 19° 46' (13'N.)	
	Venus . . .		20 51 17 39 S			Em.		15 43 or 16 ^h 27 ^m MT. (3'N.)	
	Mercury . .		21 36 15 46 S			Venus		21 11 16 30 S	
7	Sun		23 12 5 10 S		11	Mercury . . .		21 58 14 24 S	
	Moon		4 15 24 10 N			Sun		23 27 3 36 S	
	Jupiter . .		6 5 23 32 N			Jupiter . . .		6 6 23 33 N	
	Mars		12 44 1 0 S			25 Cancr. .	6	8 16 17 37 N	
	Venus . . .		20 56 17 24 S			θ	5.6	8 22 18 41 N	

MARCH.									
Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M. D. M.					H. M. D. M.	
	Moon . . .		8 26 17 2 N			Jupiter . .		6 7 23 33 N	
	52 Cancr . .	7.8	8 41 16 39 N			Im. * . . .	7.8	8 36 or 8 ^h 59' MT.	
	Mars . . .		12 40 0 33 S			*'s R.A. 13 ^h 4'		Decl. 12° 51' S. (10'S.)	
	Venus . . .		21 16 16 11 S			Em. . . .		9 36 or 9 ^h 58' MT. (5'N.)	
	Mercury . .		22 3 13 58 S			Mars . . .		12 34 0 4 N	
12	Sun		23 30 3 13 S			XII. 262 . .	6.7	12 57 13 58 S	
	Jupiter . .		6 6 23 33 N			XIII. 19 . .	7.8	13 4 12 32 S	
	Im. * 1 . .	5	6 45 or 7 ^h 24' MT.			Moon . . .		13 11 13 44 S	
	*'s R.A. 9 ^h 22'		Decl. 12° 5' N. (3'S.)			68 Virg. . .	5	13 17 11 47 S	
	Em. * 1 . .		7 48 or 8 ^h 26' MT. (10'N.)			Mars . . .		14 47 ⁺ with γ Virginis.	
	$\frac{3}{2}$ Leonis . .	5	9 22 12 5 N			Venus . . .		21 40 14 32 S	
	Moon . . .		9 26 11 31 N		17	Mercury . .		22 32 11 38 S	
	18 Leonis . .	6	9 37 12 37 N			Sun		23 49 1 15 S	
	IX. 184 . .	8	9 40 11 56 N			Jupiter . .		6 8 23 33 N	
	Im. * 2 . .	4	12 8 or 12 ^h 46' MT.			Mars . . .		12 32 0 12 N	
	*'s R.A. 9 ^h 32'		Decl. 10° 41' N. (11'S.)			XIII. 190 . .	7	13 38 18 22 S	
	Mars . . .		12 39 0 26 S			89 Virg. . .	5.6	13 40 17 15 S	
	Em. * 2 . .		13 7 or 13 ^h 45' MT. (3'N.)			XIII. 276 . .	7.8	13 53 18 57 S	
	Venus . . .		21 21 15 53 S			Moon . . .		14 7 18 24 S	
	Mercury . .		22 8 13 33 S			Im. * . . .	7	14 31 or 14 ^h 49' MT.	
13	Sun		23 34 2 49 S			*'s R.A. 14 ^h 8'		Decl. 19° 8' S. (16'S.)	
	Jupiter . .		6 7 23 33 N			Em. * . . .		15 0 or 15 ^h 18' MT. (10'S.)	
	Im. * 1 . .	7	9 31 or 10 ^h 5' MT.			Venus . . .		21 44 14 11 S.	
	*'s R.A. 10 ^h 23'		Decl. 5° 33' N. (10'N.)			Mercury . .		22 38 11 5 S	
	19 Sext. . .	7	10 4 5 29 N		18	Sun		23 52 0 51 S	
	Em. * 1 . .		10 11 or 10 ^h 45' MT. (16'N.)			Jupiter . .		6 8 23 33 N	
	Moon . . .		10 24 5 18 N			Im. * . . .	7.8	11 46 or 12 ^h 0' MT.	
	35 Sext. . .	7	10 34 5 40 N			*'s R.A. 14 ^h 59'		Decl. 22° 23' S. (15'S.)	
	38 Sext. . .	7	10 38 7 16 N			Em. . . .		12 3 or 12 ^h 17' MT. (12'S.)	
	Mars . . .		12 38 0 19 S			Mars . . .		12 31 0 19 N	
	Im. * 2 . .	6	16 35 or 17 ^h 8' MT.			Venus . . .		21 49 13 50 S	
	*'s R.A. 10 ^h 36'		Decl. 3° 15' N. (9'S.)			Mercury . .		22 44 10 31 S	
	Em. * 2 . .		17 27 or 18 ^h 0' MT. (5'N.)		19	Sun		23 56 0 27 S	
	Venus . . .		21 25 15 35 S			Jupiter . .		6 8 23 33 N	
	Mercury . .		22 14 13 7 S			Mars . . .		12 30 0 27 N	
14	Sun		23 38 2 26 S			Im. * 1 . .	7	16 30 or 16 ^h 39' MT.	
	Jupiter . .		6 7 23 33 N			*'s R.A. 16 ^h 4'		Decl. 25° 1' S. (6'N.)	
	Moon . . .		11 19 1 21 S			Im. * 2 . .	7.8	16 37 or 16 ^h 46' MT.	
	91 Leonis . .	4.5	11 28 0 9 N			*'s R.A. 16 ^h 4'		Decl. 25° 1' S. (7'N.)	
	XI. 182 . .	8	11 46 0 27 S			Em. * 1 . .		17 31 or 17 ^h 40' MT. (16'N.)	
	XI. 213 . .	7	11 52 0 46 S			Em. * 2 . .		17 38 17 ^h 47' MT. (10'N.)	
	Mars . . .		12 36 0 11 S			Venus . . .		21 54 13 29 S	
	Venus . . .		21 30 15 14 S			Mercury . .		22 50 9 58 S	
	Mercury . .		22 20 12 37 S		20	Sun		23 59 0 3 S	
15	Sun		23 41 2 2 S			Jupiter . .		6 9 23 33 N	
	Jupiter . .		6 7 23 33 N			Mars . . .		12 28 0 35 N	
	Em. 1 Sat. .		9 29 or 9 ^h 56' MT. (78)			Venus . . .		21 59 13 6 S	
	XII. 35 . .	8	12 9 7 55 S			Mercury . .		22 56 9 22 S	
	Moon . . .		12 15 7 49 S		21	Sun		0 3 0 20 N	
	22 Virg. . .	5.6	12 25 8 29 S			Jupiter . .		6 9 23 33 N	
	χ Virg. . .	6	12 30 7 2 S			Jupiter and II Gemini dif. Lat. 2'			
	Mars . . .		12 35 0 4 S			Mars . . .		12 27 0 43 N	
	Venus . . .		21 35 14 53 S			Venus . . .		22 4 12 42 S	
	Mercury . .		22 26 12 8 S			Mercury . .		23 2 8 45 S	
16	Sun		23 45 1 38 S		22	Sun		0 7 0 44 N	

MARCH.									
Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.	Days.	Planet's or Star's Name, &c.	Magnitude of Stars.	Sidereal Time.	Planet's or Star's Declination.
			H. M. D. M.					H. M. D. M.	
	Jupiter . .		6 9 23 33 N			Venus . .		22 32 10 19 S	
	Em. 1 Sat.		11 53 or 11 ^h 51' MT. (85)			Mercury . .		23 39 4 41 S	
	Mars . . .		12 26 0 51 N		28	Sun . . .		0 29 3 5 N	
	Venus . .		22 9 12 19 S			Jupiter . .		6 12 23 33 N	
	Mercury . .		23 7 8 9 S			Em. 2 Sat.		8 43 or 8 ^h 19' MT. (91)	
23	Sun . . .		0 10 1 8 N			Mars . . .		12 17 1 39 N	
	Jupiter . .		6 10 23 33 N			Im. * 1 . .	7	17 6 or 16 ^h 40' MT.	
	Mars . . .		12 24 0 59 N			*'s R.A. 23 ^h 26' Decl. 0° 21' N. (2' N.)			
	Im. * . .	8	15 7 or 15 ^h 1' MT.			Em. * 1 . .		17 35 or 17 ^h 9' MT. (14' N.)	
	*'s R.A. 19 ^h 36' Decl. 21° 56' S. (1' S.)					Im. * 2 . .	6	18 8 or 17 ^h 42' MT.	
	Em. . . .		16 12 or 16 ^h 6' MT. (6' s.)			*'s R.A. 23 ^h 27' Decl. 1° 8' N. (14' S.)			
	Venus . .		22 13 11 56 S			Em. * 2 . .		18 26 or 18 ^h 0' MT. (10' s.)	
	Mercury . .		23 13 7 29 S			Venus . .		22 37 9 54 S	
24	Sun . . .		0 14 1 31 N		29	Mercury . .		23 45 3 57 S	
	Jupiter . .		6 10 23 33 N			Sun . . .		0 32 3 29 N	
	Mars . . .		12 23 1 7 N (Opp.)			Jupiter . .		6 12 23 33 N	
	Venus . .		22 18 11 32 S			Mars . . .		12 15 1 46 N	
	Mercury . .		23 20 6 49 S			Venus . .		22 41 9 29 S	
25	Sun . . .		0 18 1 55 N			Mercury . .		23 52 3 10 S	
	Jupiter . .		6 10 23 33 N		30	Sun . . .		0 36 3 52 N	
	Mars . . .		12 21 1 15 S			Jupiter . .		6 12 23 33 N	
	Venus . .		22 23 11 9 S			Jupiter . .		10 38 and μ Gemini.	
	Mercury . .		23 26 6 9 S			Mars . . .		12 14 1 54	
26	Sun . . .		0 21 2 18 N			Venus . .		22 46 9 4 S	
	Jupiter . .		6 11 23 33 N			Mercury . .		23 58 2 23 S	
	Mars . . .		12 19 1 23 N		31	Sun . . .		0 39 4 15 N	
	Venus . .		22 28 10 44 S			Jupiter . .		6 13 23 33 N	
	Mercury . .		23 32 5 25 S			Em. 1 Sat.		8 52 or 8 ^h 15' MT. (94)	
27	Sun . . .		0 25 2 42 N			Mars . . .		12 12 2 1 N	
	Jupiter . .		6 11 23 33 N			Venus . .		22 51 8 39 S	
	Mars . . .		12 18 1 31 N			Mercury . .		0 5 1 36 S	

ART. XV. *Proceedings of the Royal Society.*

The meetings of the Royal Society were resumed for the season on Thursday evening, the 20th of November, when the Croonian Lecture was read by Sir Everard Home, Bt., V.P.R.S. It consisted of observations on the Anatomy of the Human Brain, as compared with that of fishes, insects, and worms.

The Rev. Daniel Creswell, D.D., and John Bayley, Esq., were elected into the Society.

November 27.—A paper on the Migration of Birds, by the late Dr. Edward Jenner, was read. It was transmitted to the Society by his nephew, Mr. W. C. Jenner.

Anthony Mervin Story, Esq., was elected into the Society.

On Monday, December 1st, (St. Andrew's Day having fallen on a Sunday,) the Fellows of the Royal Society held their Anniversary at Somerset-House.—At 12 o'clock, when the President took the chair, there was a numerous attendance of the Fellows. The President began the business of the day, by reading the lists of the newly admitted, and deceased, members, and on the last occasion paid a tribute of respect to the memories of Dr. Jenner, Dr. Hutton, Dr. Baillie, and Colonel Lambton, by describing the characteristic labours, virtues, and talents of these eminent men.

He then proceeded to state the award of the council of the Copley Medal, to Mr. Pond, the Astronomer Royal, for his various communications, published in the *Transactions of the Royal Society*.

In a discourse which was received with the most profound attention by the Fellows, the President gave a view of the important labours which had been carried on in the Royal Observatory, since its foundation by Charles II., and which had led to the most important discoveries made in modern times in astronomical science. He entered into an animated panegyric of Flamstead, Halley, Bradley, and Maskelyne, and spoke of the glory arising to this country, from the immediate or ultimate results of their researches which, illustrated by, and throwing light upon, the mathematical laws of the motions of the heavenly bodies, developed by our own illustrious Newton and his school, have given to us the true knowledge of the system of the universe. He spoke of the benefits which had been conferred by the observations, made at Greenwich, on navigation and our maritime interests, repaying a hundred fold the liberal expenditure of government on this great national establishment.

In speaking of the labours of Mr. Pond, he mentioned that the two most important points of research to which he had directed his attention, were, the question of the parallax of the fixed stars, and observations which seem to show a considerable apparent southern motion of many of the principal fixed stars. Mr. Pond thinks there is no evidence of a sensible parallax. Dr. Brinkley, on the contrary, is of opinion that this parallax distinctly exists. "The Council of the Royal Society," said the President, "do not

mean in any manner by their award of the medal to express an opinion on this subject, for when two such observers differ, the question cannot be considered as settled :” and he paid the highest compliments to the profound mathematical knowledge, acuteness, accuracy of research, and extent of view, of Dr. Brinkley. Between his observations and those of the Astronomer Royal, the problem of parallax was now, he said, reduced within very narrow limits, but perhaps more perfect instruments and observations would be required for its complete solution.

On the supposed southern declination of the fixed stars, it is impossible, said the President, to form, at present, any correct judgment; such an important result can only be established by new observations, carried on for a great length of time, and confirmed by the experience of the best astronomers, in different countries.

He desired Mr. Pond to consider the medal as a mark of the respect of the Society for the zeal and ardour with which he had pursued astronomy, and as shewing their confidence in the general accuracy of his observations. He likewise requested him to regard it, as a pledge that future important labours were expected from him. He exhorted him to emulate the fame of his great predecessors, and to endeavour to transmit his name to posterity by similar monuments of utility and glory.

The Society then proceeded to the election of a Council and Officers, for the year ensuing, when the following Members of the old Council were re-elected.

Sir H. Davy, Bart.

W. T. Brande, Esq.

Samuel Goodenough, Lord Bishop of Carlisle.

Taylor Combe, Esq.

John Wilson Croker, Esq.

Davies Gilbert, Esq.

Charles Hatchett, Esq.

Sir Everard Home, Bart.

John Pond, Esq.

William Hyde Wollaston, M.D.

Thomas Young, M.D.

The following were chosen Members of the Council, out of the Society.

William Allen, Esq.
Major Thomas Colby.
James Ivory, Esq.
Sir James Mac Grigor, Knt.
William Marsden, Esq.
William George Maton, M.D.
Bernard Edward, Duke of Norfolk.
Edward Rudge, Esq.
William Sotheby, Esq.
Henry Warburton, Esq.

Officers for the ensuing Year.

PRESIDENT.—Sir H. Davy, Bart.
TREASURER.—Davies Gilbert, Esq.
SECRETARIES.—William Thomas Brande, Esq.
Taylor Combe, Esq.

Thursday, December 11.—A paper was communicated “on the Nature of the Acid and Saline matters usually existing in the Stomachs of Animals, by W. Prout, M.D.” The object of this paper is to prove, that the free acid, which exists in the stomach, and which frequently is thrown up in cases of indigestion, is the *muritic acid*.

M. Fourier and M. Vauquelin, of the Royal Academy of Sciences at Paris, were elected Foreign Members of the Royal Society.

Thursday, December 18. A paper was communicated by the Rev. B. Powell, entitled “an Experimental Inquiry respecting the supposed invisible heating effect beyond the red end of the prismatic spectrum.”

A paper was read “on the North Polar distances of the principal Fixed Stars,” by J. Brinkley, D.D., F.R.S.

A paper was also communicated by James Ivory, Esq., F.R.S., “On the figure requisite to maintain the equilibrium of a homogeneous fluid mass that revolves upon an axis.”

The Society adjourned over the Christmas Vacation, to meet again on Thursday, Jan. 8.

ART. XVI. ANALYSIS OF SCIENTIFIC BOOKS.

- I. *A Course of Lectures on Chemical Science, as delivered at the Surrey Institution*, by GOLDSWORTHY GURNEY. London, 1823, 8vo. pp. 310.

OUR attention was originally called to this book, by the exorbitant and solemn praises bestowed upon it in the daily and weekly papers. The *Times* holds it up as a model of scientific composition; the *Morning Post* deliberately represents it as a never-sufficiently-to-be-valued collection of new and important truths; *John Bull* says "there is no extant work on chemical science so full of important investigations;" and the *Literary Museum* concludes a critical review of its merits, by asserting that "in more than one instance, much new matter is presented to us in the way of theory as well as of practice; and the experiments by which the lectures are illustrated, are in almost every case original." With such reiterated testimonials in favour of Mr. Gurney's "Lectures," we should hold ourselves remiss in passing them over without notice, and our readers might suspect us of prejudice and partiality, attached as we are, to another school of chemistry, were we to withhold the important information, which according to the highly respectable scientific authorities above quoted, has thus emanated from the Surrey Institution.

In respect to our author's *originality*, we confess we were something startled at finding some long and unacknowledged quotations in the introductory lecture from works which we happened lately to have perused; but our apprehensions were speedily relieved, by the tale unfolded in Lectures II and III. For instance: "Put," says Mr. Goldsworthy Gurney, "into a glass vessel, containing water, a few grains of sugar of lead, and stir them together with a glass or other rod, the water will soon become turbid in consequence of the sugar of lead *being insoluble in that fluid*, and simply a mixture of the particles with the water will take place; if the water be minutely examined, these particles may be seen floating in it, and they will ultimately, if left to themselves, fall to the bottom. If to this *milky* fluid be now added a few drops of aqua-fortis, it will instantly become perfectly clear and transparent, and now not the minutest portion of the lead can be perceived in it. In the first instance then, it was *only a mixture*, in the latter a perfect solution, because the combination of lead and aqua-fortis is soluble in water, *whereas the sugar of lead is not so.*" p. 39.

The insolubility of sugar of lead in water was to us a new fact, and as *Thomson's System*, and *Henry's Elements*, happened to be

lying on the table, we found upon referring to the former, that water takes up 0.27 parts of sugar of lead; and in the latter, this salt is represented as "almost equally soluble in hot and cold water, viz., to about one-fourth the weight of the fluid." We hope Drs. Thomson and Henry will make a memorandum of this oversight and correct it in future editions.

A little further, in p. 46, we are told that crystals of alum exactly resemble those of natural quartz, whereas we had always ignorantly supposed that the former were octoëdra, and the latter six-sided prisms.

In the second lecture Mr. Gurney rectifies Dr. Wollaston's errors respecting the theory of crystallization, but as we *can* understand Dr. Wollaston, and *cannot* understand Mr. Gurney, we consider ourselves inadequate to discuss the question. The arguments enunciated in pages 59, 60, et seq. of our author's lecture in reference to this subject are doubtless novel and profound; that they are, to our humble capacity, unintelligible, arises doubtless from the want of his "moveable diagram," the place of which is very inadequately supplied by Mr. Scharf's immoveable lithography. With great regret, therefore, do we pass over the new facts "connected with general as well as with chemical science," and tending to explain effects "which have hitherto baffled the most ingenious inquiry," set forth in this and in the succeeding lecture. We must leave the atoms "to seize their previous partners," or let them alone as they think fit, since our downright dulness prohibits our officiating as masters of the ceremonies upon the occasion.

Our ignorance also obliges us to decline any attempt at imparting to our readers the contents of Lecture IV, on chemical affinity, which if we mistake not, Mr. Gurney refers to the same laws as those which govern "musical vibrations;" when, therefore, he talks of vibration of sound combining three to two, and five to three, constituting thirds and great sixths; of tone being produced by a series of detonations, and detonations by the sudden formation and filling of a series of vacuums; of the definite divisions of the organ pipe, and the concords of the French horn, the Æolian harp, and the musical glasses; and lastly, when we are informed that musical and chemical combinations depend on the same "regulations," that modulation is an imitation of definite proportions, and that in respect to time, every different note in the scale of music, is a simple multiple or division of the other, we unwillingly feel ourselves obliged to resign our critical labours as connected with this individual lecture, and to leave the decision upon its value and merits, to those who have more music in their souls, since our own attainments in that delightful art never exceeded the performance of the obligato part upon comb and paper, or an occasional *fantasia* upon the jews' harp. Thus much in candour to Mr. Gurney.

In Lecture V, we had hoped to have met him upon more equal grounds, but to our utter dismay, a few paragraphs brought us to a large organ, which our author undertook to build "some years since, when a very young man," and which was "admitted on all hands, to have a remarkably fine tone," though built "on theory, for I had never seen the interior of one, till I had finished mine, and knew nothing whatever practically of the construction of them." This organ was combined with a piano-forte, and together with the very pleasant anecdote brought in at p. 112, to which we refer our *musical* readers, is somehow or other intended to illustrate the doctrine of expansion, the strings of the piano being it seems expanded, and its notes flattened by heat, while those of the organ-pipes were affected in the opposite way.

At p. 119 of this lecture, we are informed that "*different COLOURS have different conducting powers in respect to heat; black conducts it the most readily, white the least so.*" This is quite new to us; so also are the following assertions (p. 121.) "Water, *unlike all other substances*, is of a greater specific gravity when in a liquid than in a solid state, which accounts for the lower parts of our rivers never being frozen." Again,—“The particles of water, previously to their assuming the state of a solid, conform to the general law of liquids increasing in specific gravity, as they lose their caloric.” This gross error is the foundation of the blunders that abound in several succeeding paragraphs.

In the lecture on electricity, we are told at p. 133, that flannel becomes positively electrical when rubbed on glass, but negative when rubbed on sealing-wax, whereas the reverse is the case. We are also told that the contact of two different metals excites electricity *in an eminent degree*; that this electricity is increased by inducing a rapid change of surface, which may be effected by the action of an acid on the metals; and that it is necessary that the solution employed, be a good conductor of electricity. This is a very summary theory of the pile; and the difference between its phenomena and those of the common electrical machine, is equally hastily despatched. "In fact," says Mr. G., "the common electrical machine differs from the galvanic battery, simply from its being defective in physical power, if we may so express ourselves." At p. 136, we are informed that the decomposing powers of electricity were first pointed out by Sir Anthony Carlisle.

"Another property of electricity," says our author, "is that whenever the connexion is made between the two poles of a battery by a good conductor, it passes silently and without any visible effect." Now in the preceding paragraph, we have just learned that the said connecting wire is magnetic, and we suspect that we have sometimes seen it red-hot, and sometimes fused. But

the per-oration of this lecture is truly delectable, and we regret, we can only find room for an abstract of it, in which, however, we shall use Mr. Goldsworthy Gurney's own words.

"I cannot avoid coming to the conclusion in my own mind, that the regularity, the beauty, and the harmony, of all the changes which take place in the material world will, one day or other, be found to depend on the one grand disposing cause of electricity." And again, after observing that the functions of animals are dependant upon chemical changes, "I expect," he says, "it will not be long before it will be as universally admitted, that those chemical changes are brought about by electrical causes."

"That organic matter has some influence on the mind, cannot for a moment be doubted, and that the stomach is the chief source of this influence seems equally certain. Further it is well known, that a sympathy of the most intimate nature exists between the skin and the stomach. Now, holding, as I do, that all organic changes are in some way or other dependant on electrical agency, and that that agency is mainly available to us by means of the atmosphere, which serves as a conductor of electricity between the clouds to the earth and the human body, can it be considered as too fanciful a supposition, if I attribute the various changes of state in the human temperament, especially in persons of a nervous and irritable habit of body, to corresponding changes in the electrical state of the surrounding media, such as the earth and the atmosphere?" pp. 142, 143.

Now without meaning any disrespect to our author, we must beg leave to set this down as an unequivocal sample of that figure of speech usually called nonsense; and he should remember that much may be said in a lecture, and even plausibly urged in the warmth of argument, which will not bear to be printed and published.

We have of late heard a great deal of talk respecting the temperature of mines, and the evidence thus afforded of a source of heat within the earth; upon this subject we have always been sceptical; and rather than adopt the preposterous Beccherian notion of a central fire, have contented ourselves with viewing the phenomena as dependant partly upon the increased density of the air and its consequent diminished capacity for heat, at great depths, and partly upon other more obvious causes; but Mr. Gurney in his lecture on combustion, has set us right upon this head. "Combustion is one of those grand operations which are constantly going on within the bowels of the earth, where it serves the important purposes of composing and decomposing an immense variety of substances necessary to the renovations and revolutions which are perpetually going on among all organic as well as inorganic matter." p. 151.

In this same lecture we learn, at the bottom of p. 154, that it is impossible to make a room air-tight, and that health is injured in exact proportion as we do it; but a few lines further on we are told, that if the room be heated by flues, it may *safely* be made air-tight!

At pages 156 and 157, there are some sharp remarks upon Sir H. Davy's experiments respecting the temperature of flame, which according to Mr. Gurney, involve much contradictory evidence. Now as we have unfortunately not profited by Mr. Gurney's tuition, but happen to have received part of our chemical education under the former master; and as we belong to a school, one object of which is to teach his doctrines, and set forth his discoveries, we cannot be supposed to come unprejudiced to the consideration of our author's views, and therefore leave the determination of this subject to less biassed judges, observing at the same time, that we have looked in vain for those interesting discoveries which Mr. G. tells us he has made (p. 163) relating to gaseous bodies.

Thus far we have exposed our author's methods of handling the higher departments of chemistry; we now descend to the more immediate drudgery of the laboratory.

At p. 180, Mr. Gurney attributes to the "*upper sides*" of the leaves of plants, those functions which chiefly belong to their lower, and generally unvarnished, surfaces; and at p. 184, we find that "metallic oxides are generally reduced by the aid of *fluxes*, one of which is *carbon*," which in our conception of the term is no flux at all.

Speaking of the composition of water, it is stated to consist of 85 oxygen, 15 hydrogen; the proper numbers are 89 and 11. Nitrous oxide is said to contain 1 nitrogen and 2 oxygen by volume—those numbers should be reversed; and it is incautiously asserted that this gas may be breathed not only without injury, but often with benefit, for Mr. Southey, the Poet Laureate, declared that the sensations he experienced, were perfectly new and delightful!

In the 9th lecture we are informed that "it is *likely* that the Aurora Borealis consists of hydrogen gas, sustained at a certain elevation in the air, in virtue of its lightness, and ignited from time to time by electricity. The ignis fatuus also consists chiefly of hydrogen, in combination with phosphorus, generated by the decomposition of vegetable matter, and lighted by the heat given out during the act of decomposition," all which to our obtuse understandings, appears very *unlikely*, though the reasoning if not brilliant is at least luminous.

A little further on we are told, that the air emitted from the lungs consists of nitrogen and carbonic acid, and that as soon as it escapes from the mouth, the nitrogen ascends, and the carbonic acid descends, "thus preventing all danger of our again taking in

what was breathed out, precisely because it was unfit to benefit and sustain our animal functions." Yet in the same lecture Mr. Gurney dwells upon the "quality of permanently-elastic fluids of *interfusing* themselves equally amongst each other, when they are in contact."

Our chemical readers are probably aware that the nature of nitrogen is a problem which has attracted the attention of almost all eminent chemists, they will therefore naturally be anxious to learn Mr. Gurney's notions on the subject which are thus modestly set forth.

"Nitrogen I suspect, is a peculiar compound, formed by the organs of the animal body, and not a simple element as is generally supposed." "Under strong suspicion that nitrogen is a compound, and not a simple element, I am now prosecuting a series of experiments with a view of satisfying my mind upon this subject;" "and from the experiments I have already made, I am disposed to believe that it is not a simple substance, but a compound of oxygen, and hydrogen nearly in equal proportions." p. 202.

But this lecture teems with novelties, for at p. 204, we find to our infinite satisfaction and surprise, that "charcoal contains 64 parts of pure carbon united to 36 parts of oxygen in every 100 parts," and "that it forms nearly the whole body of the vegetable kingdom," and "gives their peculiar character to those very rocks and cliffs, which form an impregnable barrier round the island which we inhabit, and render it inaccessible to the inroads of any foreign enemy, or even of the ocean itself."

By this time, any moderate reader will be satisfied with the "novelties" offered by our author, under the heads of nitrogen and carbon; turn we therefore to phosphorus. Phosphorus, we are told, is exclusively an animal product, and is "generated, or at least makes its appearance during the conversion of vegetable and mineral into animal matter," and that it has "some mysterious connexion with animal life. In proof of this, it is found, that several animals possess the power of generating and giving forth this substance at will." The glow-worm, the fire-fly, &c., are next cited as instances!

In the lecture on the metals, there is an uncommon scarcity of those blunders and mistatements, or *novelties*, as one of the writers above quoted calls them, which pervade the other discourses; yet there are a few interspersed, as for example: "Nitrate of silver is so powerful an antiseptic, that a single ounce of it dissolved in 1200 ounces of water, will preserve the water in a state of purity *for ever!* The nitrate of silver is deleterious in its effects on the animal system; but when the water thus preserved is needed for use, the whole of the silver may be separated from it in a few minutes, by adding a small portion of muriate of soda or common salt," p. 217. In the same page, a compound of silver

and nitric acid is said to have uncommon fulminating powers ; and further on, iridium, osmium, rhodium and palladium are represented as probably alloys of other metals, for this satisfactory reason, "since they are found no where but in the ore of platinum." At p. 220, it is affirmed, that the muriatic acid of commerce "always contains a portion of corrosive sublimate, *which is an oxide of mercury*;" and again, "mercury has a very strong affinity for gold, and may be seen to fix itself, and change the colour of this metal, even through the skin and apparel of those persons who have taken it to any extent; *this is a very common case in the West Indies where so much calomel is used!*"

In the lecture on acids and alcalis, there is a sad nomenclatural jumble at p. 234; and at p. 236, we find, that "what is sold as *soda water* ought to be simply pure water impregnated with this gas; but I am afraid this is very seldom the case." So are we.

Mr. Gurney is very unhappy in assigning to Dr. Priestley the due merits of his discoveries; he never mentions his name without coupling with it some unaccountable absurdity; our readers may take the following as a specimen. Speaking of Dr. P.'s experiments on the products of fermentation, he says, "the result of that inquiry was, the discovery of carbonic acid, which he called *dephlogisticated air*. This name was changed afterwards to *fixed air*, because it is found fixed in almost all vegetable substances." p. 236. Such a cluster of incongruities, it would be difficult to match.

Nitric acid is stated to be a compound of five to two—five of oxygen to two of nitrogen—five *what* of oxygen? two *what* of nitrogen? Here our author is evidently floundering amidst volumes and atoms.

To those who are desirous of a concentrated specimen of Mr. Gurney's eloquence, originality, and scientific acumen, we strenuously recommend the perusal of his twelfth lecture, from which we shall offer a very few extracts only.

After candidly telling his audience that he is now to occupy their time with conjectures and guesses, about which, he is himself, far from being satisfied or convinced, he observes that he feels no reluctance on this score, having had practice enough in experimental philosophy "myself," to know that the most brilliant discoveries, and the most important facts and theories, not only may arise out of happy guesses, but that the "most brilliant of these which we boast the possession of, have actually arisen out of those, rather than out of a direct course of study and experiment." Now our limited experience conducts us to a diametrically opposite conclusion, and leads us to infer, that with the sweat of his brow, and the labour of his hands, man must earn his knowledge as well as his subsistence. As to the discoveries of his own, to which Mr. Gurney "himself alludes," we are as yet in dark ignorance,

unless that of the composition of nitrogen already before our readers, be alluded to.

Our author then touches upon moral philosophy, in which, he says, "as there is no beginning to our conjectures, there is no chance of their arriving at any end. If we begin to guess at all, as to the nature of moral causes, we may guess about them as much as we please; for there is no reason why we should ever stop. And in fact, about that which we actually know nothing, we never can, by any possibility, know any thing, except through the interpretation and revelation of a superior power," &c. Now all that we can possibly conclude from this passage is, that the latter part of it applies with singular fitness to Mr. Gurney's chemical knowledge.

But where so much "important matter of fact" is brought before us, we must not waste our space in these "shrewd conjectures and happy guesses," we therefore hasten to give our readers a spice of Mr. Gurney's notions, concerning "the effects of light in natural phenomena."

In the first place he tells us, that "light as well as heat is a modification of electricity," and that the various colours of plants are derived from metallic oxides, undergoing various changes, occasioned simply by their contact with light on the surface of the plant, and that during the night plants give out nitrogen. But all these "novelties" are trifling to those propounded by the truly original Mr. Gurney, in respect to animal functions. He asserts, and in sober seriousness too, that "the blood in animals contains iron and other metallic oxides, which not only occasions its particular colour, but determines its fitness for regulating the functions and renovating the powers of the system. Persons excluded from light become first pale and sallow, and finally sickly and diseased. Perhaps this may arise chiefly from the imperfect oxidation of the blood, occasioned by the absence of light." "Coloured bodies are all better conductors of heat than white, therefore animals clothed in white under the frigid zone, are better able to bear severe cold." At p. 262, et seq., there is abundance of analogous talk concerning "moonlight, the cheek of beauty, magnetism, sunshine, and electricity," which is offered with great diffidence, "because it is only lately that I have made the matter a subject of my thoughts."

But we must draw to a close. We have elsewhere complimented Mr. Gurney on his originality—his modesty induces him (p. 269,) to hope that he may allude to what he has said and done, as being with few exceptions novel and original, and may therefore meet with more indulgence than if he had pursued the common and beaten track; and finally, he concludes with the following peculiarly condescending and complacent paragraph.

"I would beg permission, also to refer to the new matter, in the way of theory, as well as of practical discovery, that I have been

led to offer to your notice, because it gives me an opportunity of stating publicly and unequivocally, that any good which may result to science in general from those discoveries, as well as any credit or advantage that may accrue to me in after-life, from being the agent in these discoveries, is due to my connexion with this Institution, for I will frankly confess to you that but for that connexion, it is more than probable, I should never have been led to make them."

We must now take leave of Mr. Gurney and of our readers. We recommend the former to waste no more time in original researches—no more money in puffing his book; and before he again tries his hand at a course of lectures, to peruse Mrs. Marcet's "*Conversations*" and Parkes' *Catechism*.—The latter are respectfully informed, that Mr. Gurney's Course of Lectures is printed for Messrs. Whittaker, in Ave-Maria Lane, and may be had at all the Booksellers.

P. S. We had almost forgotten to mention, that a lecture on the blowpipe is appended to this volume. Its style, as we might expect, is rather more inflated than that of the preceding discourses, but in "novelties" it yields to none of them. Among other valuable and original suggestions, we here find a proposal for illuminating our theatres by the light emitted from quicklime, under the influence of what Mr. Gurney elsewhere calls the Ox hydrogen blowpipe.

II. *Supplement to the Comparative Estimate of the Mineral and Mosaical Geologies, relating chiefly to the geological Indications of the Phenomena of the Cave of Kirkdale. By the Author of the Comparative Estimate.*

THE confidence which we expressed, in our review of Mr. Penn's *Comparative Estimate* that he would find little difficulty in reconciling the phenomena of the Kirkdale Cave with his geological interpretation of the Mosaic account of the creation, was not unfounded, and we are happy to find that he has anticipated our expectations, and laid his views before the public in the form of a supplement, without waiting till a second edition of the original volume shall be called for. Mr. Penn informs us in a prefatory note, that, "the following pages were first drawn up, with a view to the extension of the conclusion of chapter 6, part 3 of the *Comparative Estimate*, and to a new chapter immediately to succeed it," in a second edition, but in justice to the purchasers of the first, he has embodied the whole in the present supplemental volume. "The curious and important question to which it relates, could not have been anticipated in the first edition, as the work was printed before this new and interesting subject had been fully and distinctly brought before the world."

After the unqualified approbation which we have expressed in our 30th Number, of Mr. Buckland's *Reliquiæ Diluvianæ*, we shall hardly be suspected of any wish to undervalue that most able and interesting work, nor, from the equally decided commendation which we bestowed on the *Comparative Estimate*, in our 29th Number, can it be expected that we shall abandon our author, or hold his arguments for the strict and literal interpretation of the sacred text, by the united agencies of historical, moral, and physical evidence, in lighter estimation now than we did then.—On the contrary, the *Supplement* has strengthened our conviction of their force and justice, and proportionately exalted our opinion, high as it was before, of the talents and right-mindedness of the individual who urges them. Nor is this feeling at all incompatible with our admiration of the author of the *Reliquiæ Diluvianæ* and his delightful book, which for accuracy of observation, clearness, and minuteness of detail, stands unrivalled. But our object is not to draw a comparison between the two works, or the abilities of their respective authors, (for both we have the highest respect,) but to lay before our readers, as briefly as possible, the grounds on which Mr. Penn endeavours to shew the perfect accordance of the phenomena detailed in the *Reliquiæ Diluvianæ*, with the views he has promulgated in his *Comparative Estimate*.

It was suggested in that work, that the animal remains discovered buried *singly* in strata of gravel and clay, and those found in *multitudinous masses* in cavities of rocks, may very probably have resulted from one and the same revolution in different localities, and therefore that it is unnecessary, and unphilosophical to resort to different revolutions to account for the diversity. This suggestion, at which the time it was made, was founded on general probabilities, for want of more minute information, is now confirmed by the important and extensive means, recently supplied to us, of comparing the character and nature of the rocks, in which, in this and other countries, the innumerable mingled fragments of tropical animals occur, and which reveal to us the great geological fact, that all those rocks belong to one and the same class, *viz.*, limestone, whose texture and composition bear unequivocal evidence, by the intimate and multitudinous incorporation into their substances, of *marine organic remains*, that they were *not indurated, but soft and plastic*, when they rested in enormous masses, on the bed of the primitive ocean. "We may conclude," says D'Aubuisson, "from these *incorporated evidences*, that there are few facts in natural history established on such strong proofs as the aqueous fluidity of secondary soils, properly so called." Thus we recognise a period, in which the *substance of limestone* existed, not hard and consolidated above the waters, but soft and yielding within them. This idea of the original soft state of secondary limestone is strengthened by the analogous phenomenon mentioned by Saussure as being daily exhibited by the sands on the border of the sea near Messina, which, though still

moveable when the waves accumulate them on the beach, gradually harden to such a degree as to serve for *millstones*.

To this soft bed, our author supposes the congregated masses of bodies of animals of all races and climates, confusedly crowded in close contact, to have been transported from the southward in a northerly direction, by the reflux current of the departing ocean, (as stated at length in the *Comparative Estimate*;) and to have been simultaneously deposited on, and finally immersed, by the turbulent vortices of the diminishing waters, in those parts of the then sea bed, which are now become Germany and England; "like the bodies of elephants and other animals, whose remains are found *separately* and *singly* plunged into beds of *clay*. Let us therefore endeavour to trace the probable and natural consequences of that vast and amazing operation, and let us observe to what *correspondence with the phenomena of the caves in question* they will conduct us."

Imprimis, the frame-work of the different animals would be shattered by the concussion they must have experienced during the transport, and at the moment of their immersion in the calcareous bed; and their skeletons, thus dislocated and fractured within their integuments, would be prepared to separate their parts, when the flesh and skins had decayed.

On the final departure of the sea, the soft mass would remain in its actual position, together with the substances it enclosed, and at length become indurated secondary rock, and it would be stratified, in consequence of the successive cumulations, at different intervals, of the plastic matter from which it was derived, and the strata would form regular horizontal planes, because they were deposited from suspension in a fluid.

As the mass dried, the foreign matter enclosed in it would be more or less detached from its substance, and left in a *nidus* or *cavity*, the size of which would depend partly on the original quantity and bulk of the foreign matter, partly on the degree of resistance it was capable of opposing to the contracting mass, partly on the expansive force of the gases arising from its putrefactive fermentation, and partly on the degree of compression to which, from various causes, it had been subjected; and from the last cause, always considerable, the already dislocated and fractured bones, must probably have been still more crushed and splintered, and the whole reduced within a much smaller space than it at first occupied. The fluid discharged by the drying and hardening rock, percolating through the limestone, would form stalactites, depending from the roof; the more copious droppings would keep the slime or mud which entered with the carcasses, for a long time in a liquid state, and that portion which drained down the sides and flowed to the bottom of the cavity, would form a solid floor of calcareous stalagmite, beneath the mud; whilst what fell directly

from above, would shoot out in branches of similar stalagmite, in striving to percolate downwards through it ; or, if the mud were firm enough to support it, would form a crust on its surface. In the mean time, the animal substances, occupying the interior of the cave, would continually diminish by decomposition, and having been defended by their integuments from *rolling* or *trituration* during their transport, and from the time of their first immersion, such portions as had not decayed and perished, would necessarily exhibit surfaces wholly *untriturated* ; moreover, because all the bodies were immersed *simultaneously*, in one vast united mass, no alternations of animal and mineral matter could have taken place.

Crevices and fissures in cavities lying near the surface would naturally be produced by the drying of a mineral paste saturated with water, and suddenly and permanently exposed to the action of air and heat ; or, if the enclosed bodies were in very large numbers, the gases evolved by their decomposition might have distended the soil of the sides whilst yet soft and yielding, and even have forced their way through the weakest part, so as to form channels and orifices bearing no geometrical proportion to the original bulk of the bodies themselves.

“ This operation, and its general effect upon the bodies, would only be a *vast enlargement* of that which we so commonly witness on a *minute scale*, in limestone rocks containing shells. In those rocks, in consequence of a similar process of exsiccation producing contraction and compression of the mineral mass, we sometimes observe the shells to be broken, sometimes altogether crushed, and sometimes again entire and freely moveable within their little cavities ; and we often perceive the sides of those cavities to be coated with small crystals produced by the filtered fluid, as in the large cavities by stalactite. Now ‘ that which is so readily imagined on a *small scale*,’ observes justly Dr. Mac Culloch, ‘ is as easily transferred to a *larger* ; since, in the operations of nature *these terms are of no moment**.’ We obtain, therefore, from what has been here exposed, a strong philosophical probability that the accumulated and mingled masses of tropical and other animals, whose bony fragments have been found in Germany and in England, assembled in vast congeries in the interior of one and the same class of secondary rocks ; containing also in their substances, in numberless instances, fragments of shells and other marine organic remains ; were there enveloped, after transportation and deposition, *by the substance of the rock during its pristine state of fluidity in the bottom of the primitive sea* ; just as the *shell* was unquestionably involved by the same substance *during its pristine state of fluidity*, and in no other manner ; that the *cavity* in which they are found, was originally moulded upon the general surface of the aggregated

*- *Geological Description of the Western Islands of Scotland*, vol. ii. p. 10.

mass, as the *nidus* of the shell was unquestionably moulded upon its surface; and that the *orifices* and *channels* in the rock, which communicate with those internal cavities, were produced by one, or other, or all, of the causes which have been described."

The phenomena of the cave at Kirkdale, (which are too well known to our readers to require that we should detail them in this place,) appear to have been produced by such operations on the large scale, but very different are the deductions which the eloquent professor of mineralogy (as Mr. Penn justly styles the author of the *Reliquiæ Diluvianæ*) has drawn from them. According to the hypothesis which he has framed to account for the phenomena, (which, at the outset, he observes, "seem calculated to throw an important light on the state of our planet at a period antecedent to the last great convulsion which has affected its surface," and "that they afford one of the most satisfactory chains of consistent circumstantial evidence that he has ever met with in the course of his geological investigation;") the limestone existed in its present consolidated state, and with its present cavity, at the time when the animals, whose exuviae were found there, were lodged within it—and from the disproportion between the dimensions of the orifice of the cave, and the natural bulk of the larger animals, (elephant and rhinoceros,) he infers that they must have been introduced by the exertion of some of the smaller, *viz.*, the hyænas, either by individual industry, or "acting conjointly with others, piece-meal and by fragments, into the small recesses in which they are found." "The more rational idea," (more rational than the fanciful causes hitherto assigned to similar animal phenomena) "that the fossil exuviae were drifted northwards by the diluvial waters from tropical regions," says Mr. Buckland, "must be abandoned on the authority afforded by the den at Kirkdale; and it now remains only to admit, that the animals must have inhabited the countries in which their bones are found*." The cave in question he therefore considers to have been the habitation, during a long succession of years, of a colony of hyænas, who dragged into its recesses the other animal bodies, "whose remains are found mixed indiscriminately with their own;" the probability of which idea he contends is supported by the comminuted state and apparently gnawed condition of the bones, and he adds, "this conjecture is rendered almost certain by the discovery I made of many small balls, of the solid calcareous excrement of an animal that had fed on bones, resembling the substance known in the old *Materia Medica*, by the name of *album græcum*†," and which the keeper of the menagerie at Exeter Change, immediately recognised, as resembling, in form and appearance, the fæces of the Cape hyæna. "I do not know," continues the Professor, "what more conclusive evidence than this can be added to the facts already

* *Reliquiæ Diluvianæ*, p. 173. † *Ibid.*, p. 20.

enumerated to show that the hyænas inhabited this cave, and were the agents by which the teeth and bones of the other animals were there collected *." On these inferences, Mr. Penn remarks, "thus that most complete and satisfactory chain of consistent circumstantial evidence, stated in the first instance, does not appear to connect any thing more than the *general conclusion* that the animals *lived* in Yorkshire, with the *premises* that their remains are now *found* there;" and he compares the *process* by which those inferences are obtained, to that by which the mineral geology, peremptorily inferred from the spherical figure of the earth that "*it really was once fluid*†."

Our author then proceeds to adduce several insurmountable objections, to which he contends that the hypothesis of the hyæna's den is liable, which we shall briefly recapitulate.

1. It has omitted to inquire whether the carcasses of those animals being *moveable bodies*, might not have been removed to their actual stations? Whether any power *capable* of removing them exists in nature? Whether such power has ever been brought into actual operation?

2. The cave at Kirkdale contains innumerable bones, not only of the larger quadrupeds, but also of *water rats*; all of which animals were, by the hypothesis, imported by the hyænas for the purposes of food. Now the bones of the larger animals resisted the teeth of the hyænas, and were only *gnawed*, by them; but the same cannot be argued of the innumerable bones of *water rats* which equally remains. "The presence of their minute and masticable bones, therefore refutes the cause assigned for the presence of the large and unmasticable bones, for no one would conclude that the hyænas spared the bones of rats, merely because they could not masticate those of elephants. Certainly not, replies the hypothesis, 'but in masticating the bodies of these small animals with their coarse conical teeth, many bones, and fragments of bones, would be *pressed outwards through their lips*, and fall *neglected* to the ground‡'.

"This retort is indeed quite unexpected; yet surely, if we ever witnessed the fate of a mouse in a cat's mouth, we are perfectly competent to judge whether so small and friable a mouthful as the body of a *water rat* within the jaws of a hungry *hyæna*, would be likely, notwithstanding the coarse conical teeth of the latter, to eject any bones or fragments of bones to testify of its fate;" and even if it did, Mr. Penn insists on the improbability that they should have *remained neglected*, in the presence of so many hyænas, young and old, as the hypothesis assumes to have co-existed in the cave, taking into the account the excessive greediness for bones, which the hypothesis tells us they are remarkable for.

* *Reliquiæ Diluvianæ*, p. 21.

† *Comparative Estimate*, p. 34, &c.

‡ *Reliquiæ Diluvianæ*, p. 34.

"The hypothesis, moreover, asks, 'if bears eat mice, why should not hyænas eat rats?' I know no reason why they should not; but if they are so peculiarly fond of bones, and yet so awkward as to drop them in the actual eating, it is most probable they would have gratified their natural propensity as soon as they felt the calls of hunger return, instead of neglecting them, and that they would thus have converted them into a *much more proportionate quantity of album græcum*, than appears by the report to have been discovered in the cave." The hyæna's fondness for bones, therefore, becomes a "strong presumptive evidence that this rich treasury of bones of all magnitudes was never in the power of a confraternity of hyænas 'whose habit it is to devour the bones of their prey'."

3. Our author questions the certainty that the small balls, called *album græcum*, were really the excrement of the hyæna, and supposes they may have been merely accidental conglobations of the sediment in the cave, which is stated to have consisted of a *soft mud, or loam, mixed with much calcareous matter, which seems to be derived, in part, from comminuted bones*†. This strikes us as the weakest part of our author's objections to the hypothesis, and we think he must have forgotten that the *album græcum* was submitted to analysis by Dr. Wollaston, "who found it to be composed of the ingredients that might be expected in fæcal matter derived from bones, viz., phosphate of lime, carbonate of lime, and a very small proportion of the triple phosphate of ammonia and magnesia‡." No mention is made of the presence of *alumina* which must have been found in them had the balls been formed of the sediment of the cave, the substance of which is said to have been an *argillaceous* and slightly micaceous loam§, mixed with the calcareous matter, &c. The conjecture with which Mr. Penn concludes this head, is more forcible; "if the animal fæces could have remained in the cave undissolved by the diluvial waters, which the hypothesis supposes to have occupied it during the period of their continuance on the earth, an accumulation of the same substance would probably have been discovered underneath the diluvial mud, answering by proportion to the number of those inhabitants in their succeeding generations, and to the duration of their tenancy; which does not appear to be the case from the terms of the report."

4. The supposed marks of hyænas' teeth on the larger bones, Mr. Penn very rationally conceives may be attributed to a variety of totally different causes, and very justly exclaims, "it is too much to call upon us in this period of the world to acknowledge the remarks on antediluvian bones found in Yorkshire, for evidences of

* *Reliquiæ Diluvianæ*, p. 37. † *Ibid.*, p. 10. ‡ *Ibid.*, p. 20.

§ *Ibid.*, p. 10.

hyænas' teeth, and to make the *truth* of *geology* to depend absolutely upon *that acknowledgment*."

5. The finding, in a German cave, of the "bones of a bear, so small that it must have died immediately after its birth," is no *proof*, as the hypothesis contends, "that animals lived and died through successive generations in the cave in which we find their remains," for since the diluvial waters swept away at once an entire animal creation, of all ages and generations, where we find the exuvæ of the *old*, we shall expect to find the exuvæ of the *young* also, "and then the remains of a *hyæna cub* in England, or a *bear cub* in Germany, will no more testify to their having been *born* in those countries, or to their parents and progenitors having lived and died in them, than the remains of a drowned *puppy* on the beach, or in the drain to which the flux of the tide may have driven it."

6. Our author contends that the popular tales collected by Busbequius (quoted at p. 22, of the *Reliquiæ Diluvianæ*;) cannot lay claim to much authority at the present day, and that it does not appear from natural history that it is the custom of hyænas, and other beasts of prey, to convey their booty to a den, "*and that always the same den*," and there to devour it. On the contrary, natural history informs us, that lions, and other carnivorous animals ravenously devour their food on the spot where they seize it, leaving behind them what they do not immediately consume; and Campbell says*, that these *remnants* form a considerable part of the food collected by the Africans during the period called the Bushman's harvest. Mr. Penn concludes, therefore, "that the hyæna's den of the hypothesis had never any more relation to reality and fact, than the lion's den of ancient *Æsop*;" that those animals eat *bones* only when they cannot get flesh, and that if "the violence of the diluvial waters" has swept away the heaps of bones which Busbequius asserts the modern hyænas of his day collected *round* their dens, and which, consequently, cannot now be shown, "it is only the more necessary that the hypothesis should show us the *inside* bones of the dens of modern hyænas."

7. He denies that natural history supports the assertion that hyænas divide large carcasses into small portions in order to convey them through a small orifice, either by individual labour, "or acting conjointly with others."

"But that which constitutes the most weighty and really important objection to this ingeniously inventive *hypothesis*, is its direct contradiction of the philosophical conclusions of the *Mosaic* geology, whilst it is unprovided with any counter principles, deduced from that or any other geology, of virtue to invalidate those conclusions." The hypothesis is founded on the

* *Travels to South Africa*, vol. ii. p. 19, 20.

superficies of present and sensible phenomena, and seems afraid of venturing to ascend to the principles which generated them. "The *Reliquiæ Diluviana* has indeed ably and unanswerably added to the demonstrations of the truth of the sacred history of a deluge; not by hypotheses of hyænas' dens, but by its sagacious discrimination between *alluvial* and *diluvial* productions; and by its enforcement of the amazing proofs of inundation *at high levels*;" and the conviction we thus obtain of the truth and consistency of the sacred historian in this respect, stimulates us to seek the same character in his history of every thing which preceded that event, up to the hour of creation.

By combining the history, given us by Moses, of the creation, with his history of the destruction of the former earth, and by comparing both with the actual phenomena of our globe, "we have found the most powerful evidences conspire to substantiate the *transport* of the dead bodies of a former animal creation, from the tropics towards the poles," but none to support the supposition of the hypothesis, that animal genera, now confined to the tropics, once inhabited northern Europe; none that the relations of the sun and the circles of the earth have ever so much varied as to produce the climate of the torrid zone in the polar vicinities of the temperate, essential to that supposition. In short, the point at issue resolves itself into this question; "Whether the *exuviæ* went to a polar climate, or a polar climate has come to the *exuviæ*."

Buffon supposed our earth to be a bit of the sun knocked off by a blundering comet, and that it gradually cooled as it passed through space; "the eminent author of the hypothesis of the hyæna's den" cautiously abstains "from committing himself by any opinion as to what the cause of the change of climate was;" nevertheless he decidedly thinks that the presence of the remains of tropical animals at Kirkdale, proves them to have been antediluvian inhabitants of Britain, and that, therefore, the northern latitudes were probably warmer before the deluge, than they are at the present day. The direct contrary to this is asserted and supported by Daines Barrington*, who says, "that the seasons have become infinitely more mild in the northern latitudes than they were sixteen or seventeen centuries ago;" and the Abbé Man concludes from numerous testimonies that all the countries from Spain to the Indies, and from Mount Atlas to Lapland, have passed from extreme humidity and cold to a great degree of dryness and warmth†.

* *Philosophical Transactions* for January 18, 1768.

† *Memoires sur les grandes gélées*, &c.

The increasing temperature as we descend into deep mines, has lately been adduced as an argument in favour of the hypothesis of the gradually diminishing heat of the earth. The following solution of the phenomenon

This must be so if our earth was the former sea bed, but if its surface was merely covered by the diluvian waters, for about twelve months, though they might for a time have caused a lower temperature than prevailed in it prior to the deluge, yet it would eventually recover, on drying, its original temperature, but by no means become *hotter* than before. Thus, to whatever period we refer, we find the climate of Siberia or Yorkshire equally unadapted, as at the present day, for elephants, hyænas, &c., to have lived in them, and "that discovery becomes collateral demonstration, that the animals, whose remains are found in them, did not arrive there in a state of *life*, but of *death*, and therefore at the period and by the means which we have been enabled to investigate and assign."

In the German cave mentioned by Cuvier, scarcely any exuviae of graminivorous animals were found; their contents consisted chiefly of the bones of bears, mixed with those of the hyæna, wolf, fox, tiger, &c. The difference between these animal associations and those of the Kirkdale cave, sufficiently indicates them all to have been as fortuitous as those in the Val d'Arno confessedly are; and although the hypothesis would account for the absence of graminivora, by supposing the bears to have preferred vegetable to animal food, the attempt cannot explain why they are associated

has been proposed by Mr. Miller. (*Trans. Wern. Soc.* vol. iv. part 2; and *Annals of Philosophy*, New Series, vol. vi.)

The system of ventilation adopted in mines, causes a current of air to descend from the surface, and to traverse the deepest workings, and afterwards to ascend. The air thus sent to the bottom is necessarily *condensed* in proportion to the depth of the mine, and from its diminished capacity for heat, has its temperature proportionately elevated. "The air, thus heated, traverses the works, and imparts its heat to the strata; it then ascends, and is succeeded by a fresh portion of air from the surface, which in the same way becomes heated, and imparts its heat to the strata, and they, in turn, communicate it all around. Thus in a long course of working in a deep mine, the air at the bottom is heated, and also the rocks to a considerable depth; and when the working ceases, the mine takes a long time to lose its temperature; and this is found to be the case, particularly when the mine becomes full of water, the water being found at first of a high temperature, and gradually to lose its heat, which is in consequence of the strata imparting theirs to the water, and as soon as they have given out all their heat, the water indicates the mean temperature nearly of the place.

"The reverse takes place in an old mine when re-worked; in that case, the temperature rises gradually as the working continues; and in those mines which are not worked, but in which the ventilation still goes on, I believe it will be found that they do not lose more of their temperature than can be placed to the abstraction of the other causes of heat in working mines, such as that produced by the men and the lights.

"The exact quantity of heat given out by air in proportion to its condensation, it is difficult to ascertain, but every day's experience proves it to be very considerable; and, I believe, this, added to the other obvious sources of heat in mines in a state of working, will be found sufficient to account for their high temperature."—

We believe so, too.

in the same cave with hyænas and other carnivorous animals. But these German bones are never rolled or triturated, and therefore cannot have been brought from a distance by the waters. But water can *carry on its surface* as well as *drive along its channel*, and bodies can be moved before, as well as after they are reduced to skeletons.

We may add, that if naked skeletons had been transported by being driven along by the waters over the bed of the tumultuous ocean, it is hardly possible, but that all of them must have been crumbled to dust before they could have travelled to any considerable distance. In short, comparing all the evidence, we may safely conclude, that "the same cause that floated from a southern latitude the *solitary alligator*, found within the limestone rock in Dorsetshire, floated also, from the same quarter, the *consociated elephants and hyænas*, found within a limestone rock in Yorkshire; and that the same operation that kneaded shells into the limestone rocks of Portland, plunged both the *individual* and the *compound* body in the *limestone paste*, in whose *indurated* substances, they have at length been severally discovered:" and "the concentrating weight and contractile force of the limestone, while drying, settling, and consolidating its substance, appears completely to account at once, both for the narrow space into which the multitudinous exuviæ have become compressed, and for the necessary consequence of the bones, previously shattered and fractured in their transport, being more extensively and variously split and broken to pieces." And such is the state of the fossil remains in the close and solid strata of Paris, and so Cuvier accounts for them, without the agency of "hyænas to break them up in order to extract the brains and marrow."

For our author's answer to Mr. Buckland's conclusions that the phenomena of the Kirkdale Cave decisively establish the fact that the exuviæ of the animals found in it, were not driven northwards by diluvian currents from more equatorial regions, but that the animals themselves were inhabitants of antediluvian Britain;—that a probable change of climate in the northern hemisphere, seems to follow from this circumstance; as well as the other important consequence, that the present sea and land have not changed places, we must refer our readers to the *Supplement* itself, lest we should do injustice to its logical precision and force, by attempting to abridge it. From the same motive, we forbear to dwell on his reasoning, to shew that the vertical fissures, in the present surfaces of limestone rocks, together with their caverns, are necessarily post diluvian, with a great mass of powerful argument against the general geological inferences contained in the *Reliquiæ Diluvianæ*, and many minuter details from which those inferences are deduced.

The following passage, however, is too forcible to be omitted or

abridged. "Had the cave with all its actual attendant circumstances, occurred in a *primitive rock*, as *granite*, then, indeed, there would have been a wide field for conjecture, (as to how the bones got in,) and a heavy necessity for resorting to the invention of hypothesis to find a plausible solution of the difficulty; then indeed, we must perforce have conceded to him, (Professor Buckland,) his proposition, that the 'bones found within it, were lodged in the cavities which contain them *at periods* long subsequent to the formation and consolidation of the strata in which the cavity occurs.' But as soon as it is thoroughly ascertained that the rock which encloses them is *not of primitive* but of *secondary formation*, bearing its own demonstration of *former fluidity in a sea bed*; as soon as it is farther ascertained that *all the rocks*, in whose interior similar acervations have been discovered, are of the *same secondary* formation; then we refuse to concede his proposition, because all reason for making the concession is taken away, and all necessity of resorting to the improbable anomaly, that tropical animals once *lived* in the northern regions where their bones are found, ceases at once."—"The *consolidation of the Kirkdale limestone subsequently to the introduction of the animals*, is therefore to be maintained on principles sounder, more simple, more probable, and more strongly attested, than any which have been or can be adduced to show, that *indigenous hyænas once quartered indigenous elephants in the North Riding of Yorkshire*; which nevertheless constitutes the *essence*, nay, the *very vital principle*, of the hypothesis."

Having thus shewn that the phenomena altogether fail in proving, that the Kirkdale cave "was once a den inhabited by hyænas," on which authority alone, Professor Buckland considers that the "rational idea that the fossil exuvie were driven northward by the diluvial waters from the tropical regions, can be disproved," our author concludes this part of the subject in the following words. "With this great question, thus previously solved and settled for our caution and guidance, with respect to the principles requisite for correctly reading, interpreting, and resolving the important geological phenomena described, we may securely take all the benefit of the wonderful and awful monument of diluvial power and destruction unveiled to us in the cave of Kirkdale by the energy of its active explorer; and all the enjoyment of the stores of antediluvian antiquity, which the *Reliquiæ Diluvianæ* has so liberally laid open to us, and for which our obligations are great indeed, to its pious, able, and attractive author."

The remaining pages of the *Supplement* are occupied by some masterly observations on the consistency of a *literal* interpretation of the terms in Scripture with philosophical inquiry—on the sufficiency of *two revolutions only* to account for all the actual phenomena of our earth, and the moral evidence that the six days of

creation are to be interpreted as six natural days, and not as so many periods of indefinite length.

The last passage we have quoted from our author, will serve to shew the gentlemanly tone he has assumed, and the respectful terms in which he speaks of Professor Buckland, whenever he has occasion to mention him personally—a respect most eminently his due, and in which with all our heart, we sincerely concur. A similar tone prevails throughout the whole work, and though the arguments with which Mr. Penn supports his own views, are strong and powerful, they are urged with mildness and urbanity. If they do not convince, they cannot offend.

But we must not in justice, either to our author, or ourselves, take leave of him with mere negative commendation. We think he has fully made out his case, and if any thing was wanting to satisfy us of the stability of the reasonings contained in the *Comparative Estimate*, and the accuracy of the conclusions deduced from them, they are in our opinion, amply supplied in the *Supplement* to this admirable work.

III. *Lectures on Comparative Anatomy, in which are explained the Preparations in the Hunterian Collection, illustrated by Engravings; to which is subjoined "Synopsis Systematis Regni Animalis nunc primum ex Ovi Modificationibus propositum,"* by SIR EVERARD HOME, Bart., V.P.R.S., F.S.A., F.L.S., &c.

In resuming an account of this splendid work, we must, as in the former article (p. 134), limit ourselves to its principal features only, selecting especially for our readers' notice the new facts which it embraces, and the new views which it discloses and illustrates.

In the first place, we cannot omit recording in our pages the extraordinary fact, first published by the author, of an animal, (the Dugong, in the Eastern Seas, and the Manatee in the great rivers of the Western Continent,) in which the heart is divided into two distinct portions of similar structure and equal force, the blood in its passage through the lungs requiring the same impetus as in passing through the different parts of the body. There is also a curious account of a nearly complete fossil skeleton, illustrated by engravings, which forms in itself, an important and distinct class of the antediluvian animals no longer met with on our globe. He gives it the name *Proteosaurus*, as the class to which it belongs is intermediate between the lizard and Proteus.

On the subject of generation, the author has taken particular pains, and has certainly been fortunate in his researches. The discovery of the human ovum appears to please him more than any

other he has made. In the lecture upon that subject, he expresses himself thus:—

“The discovery I am about to promulgate, was most undoubtedly the result of accident; but similar accidents have before occurred, without the discovery having been made, and now that the fact is established, there will not be wanting in every country of Europe, opportunities of confirming it. But without the aid of the microscopical observations of a Bauer, the fact even now, could not have been satisfactorily established, and with that assistance I have met with it a second time.

“That the professor of Comparative Anatomy to this college, should in his lectures be enabled to prove to demonstration the origin of the human foetus, which the great Harvey, who gave lectures upon the same subject in the neighbouring College of Physicians, was unable to discover, must be gratifying to every one of our members.”

The mode in which the discovery is detailed, is so clear and distinct, and at the same time so interesting to all who prosecute anatomical pursuits, that we shall indulge our readers with it.

“In this examination I was assisted by Mr. Clift: on observing accurately the right ovarium, there was upon the most prominent part of its external surface, a small ragged orifice; this induced me to make a longitudinal incision in a line close to this orifice, and a canal was found leading to a cavity filled with coagulated blood, surrounded by a narrow yellow margin, in the structure of which; the lines had a zigzag appearance.

“The cavity of the uterus was then opened, by making an incision through the coats from each angle, and where these met in the middle, a third incision was continued down through the os tincæ. The three angles were turned back, so as to expose the cavity, and the sides were gently separated from each other. The os tincæ was completely blocked up by a plug of mucus, so that nothing had escaped by that passage; the orifices leading to the fallopian tubes were both open, and the inner surface of the cavity of the uterus was composed of a beautiful efflorescence of coagulable lymph, resembling the most delicate moss. This efflorescence had fibres of a greater length on the posterior surface, a little way beyond the os tincæ than at any other part. Being certain that nothing could have escaped, I began gently shaking the efflorescent fibres with a needle point, and said to Mr. Clift, that if we found any thing it would be in that part. During this examination, the whole of the uterus was immersed in spirit, and the needle point in its movements brought a small transparent body above the surface of the efflorescence of coagulable lymph, but it immediately sunk again; I raised it a second time, and saw distinctly that the moment it was exposed to the spirit, it became opaque; it had an

oval shape. I cried out, 'We have got it;' Mr. Clift less sanguine, and not seeing the change of colour, my eye being directly over the basin, believed it was only a little coagulated lymph. Perfectly satisfied that I had got the ovum, I went immediately to Mr. Bauer, that he might submit it to the test of the microscope, and by this means, have the fact completely confirmed."

That all animals originate from an ovum, formed in the ovarium of the female, and afterwards impregnated, has been an opinion universally believed ever since the time of Harvey, but it is to our author, that we are indebted for the demonstrative proof of such an opinion; to him also is the merit due of having ascertained the real use of the corpus luteum, which before was not at all understood. He also has set to rest all the vague theories respecting generation, having by his experiments and observations, brought forward facts explanatory of all the occurrences, in the different stages of that most curious and wonderful operation.

The mode of breeding of the marsupial animals, in which the ovum never becomes attached to the uterus, and that of the ornithorhynchus which lays its eggs in the same manner as the bird, while they connect classes of animals together, in other respects so different from one another, will be found to be highly interesting to the philosopher, and indeed to all those who are admirers of the works of nature. That an animal should exist with so many remarkable peculiarities is so extraordinary, that some of the best anatomists of the present day, not having a conception that there could be such a construction of parts, and the specimens under their examination not being well preserved, entirely overlooked the fact. As we are not venturing to attempt more in this short article than to point out to our readers the most prominent facts which the author has laid before the public, we shall pass over what is said upon the breeding of cold-blooded animals, in which there are two sexes, and go at once to the account of those that impregnate themselves. And in this place we are ready to admit that there is a reason beyond those already given, that prevents us from venturing too far into these *terra incognitæ* of science, lest we should commit ourselves, either on the one side in praising, or on the other in condemning opinions, because we ourselves do not understand them; we therefore, repeat here, that it will require the confirmation of future labourers in the wide field of comparative anatomy, to confirm or refute the statements given by the author.

That he was the first who had the opportunity of examining the internal structure of the Teredines, and shewing, that an animal of the same description was met with in India, of so gigantic a size as to exceed in an equal degree the *Teredo Navalis*, met with in our ships, as the Clamp of New South Wales does the common oyster, is fully established by his account many years ago in the

Philosophical Transactions, and, to him we also owe the discovery of its possessing both male and female organs, and that it both formed the ova in the ovarium, and afterwards impregnated them. Having established this mode of generation in the teredines, he found the lamprey, the common eel, and the conger, to be so many different tribes of self impregnating animals. His merit upon these subjects is, however, not all his own. He is indebted to Mr. Bauer and Mr. Clift for their exertions in making drawings illustrative of the facts he brings forward, and had he not been so assisted, many doubts would certainly have hung over a great part of his labours.

He has been the means of enabling Mr. Bauer to immortalize his name, by a series of drawings of internal parts of the earth worm, and the progress that takes place in the formation of the chick, during the process of incubation, which we may venture to say will probably never be excelled. That the first part formed in that process is the brain and spinal marrow; the heart, arteries, and the other parts, being all secondary, their structure not arising out of the molecule itself, but depending upon the supplies derived from the yelk and albumen, are so many original facts of the highest physiological importance.

So much for our account of this valuable work, which were there not one single word of letter press, would be a great accession to anatomical science, since it contains more than three hundred plates, by two such distinguished draftsmen as Bauer and Clift.

On the synopsis, which is subjoined, bringing forward a new scheme for the classification of animals, we must let the author speak for himself, before we venture upon any remarks of our own.

"Every step we advance in the acquirement of knowledge in comparative anatomy, makes us better acquainted with the defects that exist in the general systems at present before the public. The truth becomes obvious, of there being no organ belonging to an animal except the brain, that will bear us out in affording characters for a general classification, the structure of the other organs being varied whenever it was necessary to adapt the animal to the climate which it is to inhabit, or the food on which it is to subsist; and the brain we are not sufficiently acquainted with to take as our guide.—There is only one fixed principle that admits of being laid hold of for that purpose, without which the whole scheme of nature would have been thrown into confusion. The principle I allude to, is that which prevents animals differently constructed from breeding with one another at all, and does not allow those that are more nearly allied, to carry on the breed beyond one generation.—The ovula of plants was to botanists, what the molecule in the ovum of the human species and quadrupeds is to the anatomist; and till that knowledge was acquired, and the changes produced in it by impregnation, were

known, with the consequent process to be gone through, by which the molecule was to become an animated being, no attempt could be made by the most intelligent physiologist, not even by a Harvey or a Hunter, in former times, or a Cuvier in our own, to form the scheme of a general classification upon the principle which is now brought forward.

The idea of such a scheme originated in finding that the human ovum, and that of quadrupeds, consisted entirely of the molecule.

In the kangaroo, that this molecule at its origin, was under the same circumstances, but that an addition is made to it before it arrives at the uterus, and in that cavity it is furnished with albumen.

In the opossum of America, the molecule at its origin, has a yelk connected with it in the ovarium, and in the uterus is supplied with albumen.

In the ornithorhyncus the molecule has a yelk connected with it in the ovarium, receives albumen in the uterus, passes through the vagina, and at the cloacae is covered by a calcareous shell and passes out of the body before it is hatched.

In the bird the molecule has a yelk connected with it in the ovarium, has a supply of albumen in the oviduct, and having no uterus, a shell is formed in the cloacae and the egg is hatched out of the body.

"So beautiful a series," as the author calls it, must naturally have made a strong impression upon his mind, but whether it will bear him out in forming a new system of the animal kingdom, or what time it will require to bring it to perfection, even if others who follow after him, should adopt it, which in these days of novelty is very problematical, are questions we are not called upon to answer, and we shall finish this article by an enumeration of the twelve classes, into which, according to this new stem animals are divided.

SYSTEMA,

REGNI ANIMALIS.

NUNC PRIMUM EX OVI MODIFICATIONIBUS PROPOSITUM.

Classes.

1. Echemetroa. Embryo ex ovo in corpore luteo formato evolutus in utero quocum adhæret.
2. Emmetroa. Embryo ex ovo vel in corpore luteo vel in vitello formato, evolutus in utero a quo solutus.
3. Ecmetroa. Embryo ex ovo vitello instructo et in utero impregnato incubatione evolutus.
4. Exostoa. Embryo ex ovo vitello instructo et in oviducto impregnato, incubatione evolutus.

5. *Enaerogenoa.* Embryo ex ovo in oviducto impregnato, absque incubatione evolutus.
 6. *Amphibigenoa.* Embryo ex ovo in ovario formato, instructus pulmonibus et branchiis nudis evolutus in aqua.
 7. *Enhydrogenoa.* Embryo ex ovo in ovario formato, branchiis operculo tectis instructus evolutus in aqua.
 8. *Metamorphogenoa.* Embryo ex ovo in ovario formato, subjectus metamorphosi, stigmatibus respirans.
 9. *Monogenoa.* Embryo ex ovo a mare monorchide impregnato, branchiis instructus.
 10. *Hermaphroditogenoa.* Embryo ex ovo hermaphroditi duplicis.
 11. *Autogenoa.* Embryo ex ovo hermaphroditi unici.
 12. *Cryptogenoa.* Embryones quorum primordia ignota.
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IV. *Philosophical Transactions of the Royal Society of London, for the Year MDCCCXXIII. PART I.*

This part of the *Philosophical Transactions* contains twelve papers, illustrated by twenty engravings, the greater part of which are very creditably executed. The following are the titles and contents of the communications.

1. *The Croonian Lecture. Microscopical Observations on the Suspension of the Muscular Motions of the Vibrio Tritici.* By Francis Bauer; Esq., F.R.S.

The animalcule described in this paper, is the cause of that disease in wheat, called by farmers *ear-cockles* or *purples*. The diseased grains include a white globular matter, which, when put into water displays, in the field of the microscope, hundreds of minute worms in lively motion. As the water evaporates they dry up and are motionless, but become as lively as ever, when re-moistened, and this after a period of more than six years. By some ingenious experiments Mr. Bauer shows that the eggs of these vermiculi are conveyed into the plant by the circulating sap, and he succeeded in obtaining infected plants by inoculating healthy grains of wheat with portions of the vermicular globules. For the dimensions, aspects, and habits, of these worms we refer our readers to the author's paper, and to the two beautiful plates which illustrate it.

2. *On Metallic Titanium.* By W. H. Wollaston, M.D., V.P.R.S.

Certain small cubes occasionally observed in iron slag, had generally been regarded as pyritical, but upon minute inspection Dr. Wollaston observed, that neither their colour, crystallization, nor hardness, were those of pyrites. These crystals, purified from

iron by muriatic acid, were insoluble in muriatic, nitric, nitromuriatic, and sulphuric acids. Infusible, but oxidated before the blowpipe, especially by the aid of nitre. Their perfect solution may be effected by the combined action of nitre and borax, since the latter dissolves the oxide as fast as it is formed, and presents a succession of clear surfaces, for fresh oxidation. But as these salts do not unite by fusion, the addition of soda, as a medium of union, shortens the process. The fused mass becomes opaque on cooling by the deposition of a white oxide, which may either be previously freed of the salts by boiling water, and then dissolved in muriatic acid, or the whole mass may at once be dissolved together.

In either case alkalies precipitate from the solution a white oxide, which is not soluble by excess of alkali, either pure or in a state of carbonate. By evaporating the muriatic solution of the oxide to dryness, at the heat of boiling water, it is freed of any redundant acid, and the muriate which remains is perfectly soluble in water, and in a state most favourable for exhibiting the characteristic properties of the metal. Infusion of galls gives the well known colour of gallate of titanium.—The colour occasioned by triple prussiate of potash is also red, differing from prussiate of copper, by inclining to orange instead of purple, while the colour of prussiate of uranium is rather brown than red.

Such experiments show in a concise and satisfactory manner that the small cubic crystals are titanium, in its metallic state, which is further proved by their being perfect conductors of very feeble electricity.

That titanium has no affinity for iron, seems evident from the situation in which the above crystals occur, and "it seems," says Dr. Wollaston, "equally indisposed to unite with every other metal that I have tried."

Its extreme infusibility renders it improbable that the cubes should have formed during cooling from a state of fusion; the author thinks it probable that they have received their successive increments by the reduction of the oxide dissolved in the slag around them; "a mode of formation," he observes, "to which we must have recourse for conceiving rightly the formation in nature of many other metallic crystals."

3. *On the Difference of Structure between the human Membrana Tympani and that of the Elephant.* By Sir Everard Home, Bt., V.P.R.S.

In man the drum of the ear is circular, and its muscular fibres form radii of equal lengths passing from the centre to the circumference; in the elephant it is oval and the muscular fibres are of unequal lengths, some being more than twice the length of others. The fine sensibility of the human ear to musical sounds,

depends, in the opinion of the author, upon the equality of the muscles of the tympanum.

4. *Corrections applied to the great Meridional Arc, extending from latitude $8^{\circ} 9' 38''.39$, to latitude $18^{\circ} 3' 23''.64$, to reduce it to the parliamentary standard.* By Lt. Col. W. Lambton, F.R.S., &c.

It appears from Capt. Kater's results that Col. Lambton's standard scale requires a multiplier of $-.000018$ to make it agree with Bird's standard; and that Ramsden's bar, used in the trigonometrical survey of Great Britain, requires the multiplier $+.00007$. That is to say, with respect to a measurement on the meridian the degree depending on Col. Lambton's brass scale must be multiplied by $.000018$, and the product subtracted from the measure given by the scale, to reduce it to the parliamentary standard. And the degree depending on Ramsden's bar, must be multiplied by $.00007$, and the product added to the measure given by the bar, to reduce it to the standard measure. The author then proceeds to correct the different sections of his arc by the above factors.

5. *On the Changes which have taken place in the Declination of some of the principal fixed Stars.* By John Pond, Esq., Astronomer Royal.

6. *Appendix to the preceding Paper—by the same.*

The mural circle having been pronounced by Mr. Troughton as perfect as when first erected, Mr. Pond resumes his observations, but finds the discordances which had so much perplexed him still continue. To place, however, the accuracy of the instrument beyond all doubt, he contrives an apparatus, which enables him to observe most of the stars by reflection, from the surface of Mercury; the result is, that several stars (and particularly those which had exhibited the greatest anomalies) thus observed, have within a fraction of a second, the same places assigned to them, as direct measurement from the pole had previously given them. Ten stars situated near the zenith, give the horizontal point of the instrument $123^{\circ} 30' 29''.54$, whilst Sirius places at $123^{\circ} 30' 29''.47$, differing only seven hundredths of a second. Hence, neither flexure of the telescope, or change of figure in the instrument, need be apprehended. The stars in which a very great deviation toward the South is found, are Capella, Procyon, and Sirius.

In the appendix to the above paper, Mr. Pond, finding that recent observations confirm the results hinted at in his last paper, investigates minutely how far the discordances between his present catalogue, and that of Bradley of 1756, and his own of 1813, may be accounted for, by instrumental error, or erroneous observation. The consequence of the inquiry is, that the present devia-

tion of the stars to the south of their predicted places, cannot originate either in the one, or the other—perceiving also that the extent of southern deviation, to which any star was liable, might better be predicted by a reference to its right ascension, than to its declination, Mr. Pond attributes the discordances to some natural cause. He observes, that instruments of well known celebrity, are said to give different results; claims no superiority for his own catalogue, from the circumstance of its being nearly a mean between those of Dr. Brinkley and Mr. Bessel, but considers each of the latter inaccurate, from flexure of the instruments, with which they were made—and states that his confidence in the accuracy of his present observations, and also in the superiority of the Greenwich circle over all others with the history of which he is acquainted, is derived from the coincidence in the results, obtained by direct and reflected vision, each at the same time giving to the instrument the same horizontal point.

7. On the Parallax of α Lyræ. By John Pond, Esq., Astronomer Royal.

The mural circle is here employed, to determine the difference of parallax, between γ Draconis and α Lyræ; and also the absolute parallax of the latter star—every care was taken, to equalize the temperature of the observatory with that of the outer air, and so nearly was this effected, that it became a matter of indifference, whether the observations were reduced by the employment of the interior or exterior thermometer—and the same results were obtained, whether two or six microscopes were used; (a circumstance strongly proving, that no cause of error need be expected from partial expansions of the limb of the instrument;) namely, that the angular distance between the two stars, measured in summer and winter, does not differ one tenth of a second—hence γ Draconis and α Lyræ have the same parallax, or their difference of parallax is = 0.

Absolute Parallax of α Lyræ.

The observations to determine this, were made by reflection as well as by direct vision; equal pains were again taken to equalize the temperature of the inner with the outer air, and with the same success; the same results were procured, whether two or six microscopes were employed. They indicate that the sensible parallax of α Lyræ, cannot exceed a very small fraction of a second. The reason why Dr. Brinkley finds no parallax in γ Draconis, a small quantity in α Cygni, more in α Lyræ, &c., Mr. Pond attributes to the nature of his instrument, which as far as the zenith point is concerned, may be considered perfect, but which in proportion, as it is directed from the zenith, becomes less and less perfect. Mr. Pond concludes the paper thus: “The history of annual

parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sensible parallax. This has happened in Italy, to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the continent; and, accordingly, it shews a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion, than that this is the reason why it discovers no parallax at all."

8. *Observations on the Heights of Places in the Trigonometrical Survey of Great Britain, and upon the Latitude of Arbury Hill.* By B. Beavan, Esq. Communicated by Sir H. Davy, Bt., P.R.S.

By levelling to the Grand Junction and other canals, the author found the country to the north of Arbury Station, suddenly to fall about four hundred feet, and to continue thus depressed for ten miles. Such a defect of matter induced him to suppose a southward deflection of the plumb-line, and by calculating the latitude of Arbury from that of Blenheim, as determined by previous observation, he found it five seconds less than shewn by the zenith sector.

9. *On some Fossil Bones discovered in Caverns in the Limestone Quarries of Oreston, by J. Whidbey, Esq., F.R.S. In a Letter addressed to John Barrow, Esq., F.R.S. To which is added a Description of the Bones.* By Mr. W. Clift, Conservator of the Museum of the College of Surgeons.

We owe to Mr. Whidbey the important geological fact of the existence of cavities containing bones, in the solid secondary limestone of Plymouth, which cavities exhibit no traces whatever of any external outlet. In his description of the cavern containing the bones of the rhinoceros, printed in the Philosophical Transactions for 1817, he particularly insists upon the uniform solidity of the surrounding rock. Sir E. Home tells us that Mr. Whidbey "saw no possibility of the cavern having had any external communication," and this singular and important circumstance is further verified as follows. "As in the contract for quarrying there are two prices, one for rock, and another for clay, earth, and rubbish, and two officers attend, one for the crown, and the other on the part of the contractors, who measure the contents of all caverns that contain clay or other soft materials, it is only necessary to mention that these officers state, that the rock surrounding the cavern was equally

hard with the other parts, requiring the same force to blast it, and that the quarrying was paid for accordingly." *Phil. Trans.* 1817. p. 177.

In the *Philosophical Transactions* for 1821, Mr. Whidbey describes some similar caverns, all surrounded by compact limestone rock, "none of which had the smallest appearance of ever having had any opening to the surface, or connexion with it whatever, or with each other;" he then goes on to say, that "many caverns have been met with in these quarries, the insides of which have been crusted with stalactite, but there was no appearance of this kind in the cavern where the bones were found, every part of it being perfectly dry, and nearly clear of rubbish; a circumstance which clearly proves it had no connexion with the surface, as in that case water would have found its way into it, the dropping of which would have formed stalactite as in other instances." *Phil. Trans.* 1821. p. 134.

In the present communication a cavern is described which, like the former, exhibits no evidence of any decided external communication or outlet, though the evidence to this point is perhaps not so satisfactory as that adduced in the former papers, to which we beg the particular attention of our geological readers, as importantly bearing upon Mr. Granville Penn's arguments noticed in a preceding article.

Mr. Clift has added to this communication a perspicuous description of the bones which are those of the bos, the deer, the horse, the hyæna, the wolf, and the fox. The bones formerly found were those of the rhinoceros, bear, and antelope.

10. *On the Chinese Year.* By J. F. Davis, Esq., F.R.S.

One of Mr. Davis's objects in this paper appears to be, to shew the folly of attributing any thing original in astronomical science to the Chinese, who were entirely ignorant of its objects and principles, before its introduction into their empire by the Arabians, and afterwards by the European missionaries. On this one subject, says the author, that singular nation has deviated from its established prejudices and maxims against introducing what is foreign,—they have even adopted the errors of European astronomy, for he discovered in a Chinese book, the exact representation of the Ptolemaic system,—he adds "indeed it is impossible not to smile at the idea of attributing any science to a people whose learned books are filled with such trumpery as the diagrams of Fò-li, and a hundred other puerilities of the same kind." Mr. Davis offers several other proofs of the talent which the Chinese possess of stealing the discoveries of other nations and appropriating them to themselves.

The author proceeds to show that the Chinese have no solar

year, but that the Chinese year is in fact a lunar year, consisting of twelve months of twenty-nine and thirty days alternately, with the triennial intercalation of a thirteenth month to make it correspond more nearly with the sun's course.

11. *Experiments for ascertaining the Velocity of Sound at Madras in the East Indies.* By J. Goldingham, Esq., F.R.S.

This paper is so full of minute details, and abounds in such extended tables of results, that we shall not attempt to abridge the data upon which its conclusions are founded. The mean velocity of sound, deduced from the experiments is 1142.34 feet in a second.

12. *On the Double Organs of Generation of the Lamprey, the Conger Eel, the Common Eel, the Barnacle and Earthworm, &c.* By Sir E. Home, Bt., V.P.R.S.

It is impossible intelligibly to communicate to our readers the curious contents of this paper, without the aid of the five magnificent plates engraved from Mr. Bauer's drawings, with which it is illustrated.

[The pressure of other matter, obliges us to postpone our account of the contents of the second part of the *Philosophical Transactions* for 1823, (published in November,) until our next Number.]

V. *The Elements of Experimental Chemistry.* By William Henry, M.D., F.R.S., &c. *The ninth edition, comprehending all the recent discoveries, and illustrated with ten plates, by Lowry, and several engravings on wood.* 2 vols. 8vo. London, 1823.

THE inertia of the human mind, and the power of prejudice, are no where more conspicuous than in the pertinacity with which compilers of scientific works continue in their successive editions to retain their early classifications of facts, amid the revolutions of the science itself. Having at first taken some pains to plan an edifice, whose proportions and interior distribution they regarded with complacency, they are unwilling to demolish and construct it anew. For the most part, therefore, they content themselves with some petty alterations in its exterior, which may harmonize it a little with modern improvement, and with replacing the decayed and obsolete furniture of some of the apartments, by other more substantial and appropriate.

The respectable author of the *Elements of Experimental Chemistry* had suffered himself, for the preceding two or three editions of his popular work, to fall under the above description. A book, however, intended especially for students, derives a great part of its value from the justness and felicity of its arrangements. Chemical phenomena have been, of late years, so repeatedly exhibited to the world in so many publications, and are, generally speaking, so clear and uncontroverted, that there is little merit in their mere collection. It is the skilful initiation of the Tyro's mind into the methods of chemical research, and the natural collocation and development of details, both as to the facts themselves, and the means by which they were discovered, that are required and expected from the author of an elementary work. In these respects, the model offered by Lavoisier has been too little imitated by late compilers of systems. By studying the elements of that philosopher, the mind not only gets stored with a series of important facts, but acquiring imperceptibly logical force and precision, becomes fitted for conducting independent investigations. How different an impression is made on the student's mind, by some of our late *systematic* performances. A multitude of objects is exhibited to his view, like a phantasmagoreal dance, calculated to bewilder and fatigue the most resolute; and altogether to deter the less zealous from entering this hermetic labyrinth.

The genuine principles of chemical classification were first established by Davy, in his Bakerian Lectures of 1806, 1807, and 1808. Here the electrical relations of the elementary or undecomposed bodies, and of many compounds were demonstrated; relations which served as the basis of his arrangement in the *Elements of Chemical Philosophy*, which he published in 1812. Berzelius indeed has long regarded the electrical relations of chemical bodies, as the ground-work of their classification, but his notions on electro-chemistry are not unfrequently obscure and hypothetical*.

Oxygen, chlorine, iodine, and fluorine, besides their electrical properties, have other characters so prominently defined, as to entitle them to a primary and peculiar place in chemical systems.

* We are sorry to observe that our censure of some of the hypotheses of Berzelius, and more especially of his system of symbols and formulæ, (which we shall, nevertheless, continue duly to administer as occasion may require) has been mischievously misrepresented as a personal attack upon the Professor, for whose talents, industry, and analytical skill we entertain the highest respect, and therefore beg leave to deprecate any such interpretation of our remarks. The most useful, judicious, and skilful, are sometimes mistaken in the estimate of their own powers; "optat Ehippia Bos piger; optat arare caballus." The high character of Berzelius as an acute and successful analyst, and the ability with which he has handled some of the most abstruse theoretical departments of chemistry, gave a mischievous authority to his hypothetical speculations, and our animadversions have been, and will be, solely confined to the latter.

All our respectable British compilers seem now fully possessed with this idea. But M. Theeand, in his third edition (1821,) of his excellent *Traité*, has neglected this principle of arrangement altogether, and has consequently created a strange jumble among the elementary substances. He begins, for instance, with oxygen, and under this head discusses the theory of combustion and of flame, as if these phenomena possessed that indispensable connexion with oxygen, which was the leading article of the Lavoisierian creed. His next great division comprehends the simple combustibles, non-metallic, which are distributed in the following order; hydrogen, boron, carbon, phosphorus, sulphur, selenium, chlorine, iodine, and azote. Thus many of the most beautiful chemical analogies are violated, to the no small perplexity of the student.

Dr. Henry has at length in this edition adopted as the basis of his arrangement, that originally given in Sir H. Davy's *Elements*, and followed up and extended in Mr. Brande's *Manual*. In the sequel of the introduction (which is the introductory lecture long ago delivered in Manchester, and reprinted in the former editions,) he has given a few paragraphs descriptive of the arrangement of the work.

The first chapter entitled "Of a chemical laboratory and apparatus," is chiefly a reprint from the former editions. Some formulæ are now added by Mr. Dalton, for equating the volumes and specific gravities of moist gases. Mr. Dalton assumes 0.620 as the specific gravity of aqueous vapour in air at 60° F, and not 0.472 as Drs. Apjohn and Thomson would have it. (See *Annals of Philosophy*, May, 1822.) "The specific gravity," says Mr. Dalton, "of pure steam compared with that of common air, under like circumstances of temperature and pressure, is according to Gay-Lussac as 0.620 to 1.0."

But as each species of gaseous matter has its volume equally affected by change of temperature, the relation 0.620 to 1, will continue to be equally just at the temperature of 60° F, as at that of 212°, at which point M. Gay-Lussac's experiments were made. Hence we perceive the fallacy of Dr. Thomson's and Dr. Apjohn's determinations in the *Annals of Philosophy* for April and May, 1822. A more popular view of this important practical subject should have been given in an elementary work. To a large proportion of chemical students, Mr. Dalton's exposition will be unintelligible. A table might have been given for reducing the volume of moist air, to that of dry, between the ordinary range of experimenting on gases, viz., from 50° to 70° Fahr.

The second chapter is entitled *Chemical Affinity*; under which head we scarcely expected to find cohesion and crystallization. Here the principles of corpuscular philosophy are inculcated; but we cannot compliment our author, either on the soundness or profundity of his views. His primary enunciation is incorrect. "All

bodies composing the material system of the universe, have a mutual tendency to approach each other, whatsoever may be the distances at which they are placed." Newton established, on the contrary, that when these distances are diminished to a certain point, the attractive forces cease to operate, and the repulsive begin to act. This subject has been amply investigated by Boscovich.

In the following sentence, Dr. Henry's language is contrary to the usage of all good chemical authors. "By the *affinity of aggregation*, the *cohesive affinity*, or more simply *cohesion*, is to be understood that force or power, by which particles or atoms of matter of the same kind, attract each other, the only effect of this affinity being an aggregate or mass." The term *affinity* thus employed, tends to introduce confusion into chemical discussions. Geoffroy originally used it to designate those relationships between two or more sets of heterogeneous particles, which caused them to unite into a compound whole; and every chemical writer since, has we believe, used *affinity* as synonymous with the *attraction of composition*, in contradistinction to the attraction of aggregation or cohesive attraction. In fact, the expression cohesive affinity is a solecism, for a thing cannot be said to have an affinity or relationship to itself. We might as well say of a person, that he is related to himself. Precision of language is a primary virtue in an elementary writer.

In the same paragraph, Dr. Henry goes on to say, "But in compound bodies, we may distinguish the force with which the *primary* or *component* atoms are united, from that which the *compound* atoms exert towards each other; the former being united by chemical affinity, and the latter by the cohesive attraction." This is a *metaphysical* distinction, which he might as well have let alone, for probability is against it. In considering for example an atom of calcareous spar, we may contemplate its solidity as resulting from the attractive affinity of an atom of carbonic acid for an atom of lime; or of one atom of calcium, one of carbon, and three of oxygen. Let a second atom of calcareous spar be brought into intimate association with the first. The aggregate may be held together either by the reciprocal affinities of the two ultimate atoms of calcium, two of carbon, and six of oxygen, or by those of the two atoms lime and carbonic acid, or by the cohesion of an atom of carbonate of lime to carbonate of lime. We cannot help recognising the co-operation at least, of the former set of forces in the formation of the aggregate; for arrange the ultimate atoms in the solid as we please, still one of carbonic acid will be situated between several of lime, and will exert a greater or less affinity for them all, relative to its position and proximity, and be acted on by several atoms of lime in return.

The first section of the Chapter on Chemical Affinity treats of

cohesion, solution, and crystallization. "The cohesive affinity," says Dr. Henry, "is a property which is common to a great variety of bodies. It is most strongly exerted in solids, and in them it is proportionate to the mechanical force required for effecting their disunion. In liquids, it acts with considerably less energy; and in æriform bodies, we have no evidence that it exists at all; for their particles, as will afterwards be shewn, are mutually repulsive, and if not held together by pressure, would probably separate to immeasurable distances. Water also in a solid state has considerable cohesion, which is *much* diminished when it becomes liquid, and is entirely destroyed when it is changed into vapour."

We have quoted this passage, not so much for the purpose of exemplifying the practice too common with some systematists of filling up their pages with trite and unmeaning generalities, as to point out its false philosophy. Fully a year before Dr. Henry's work appeared, Dr. Wollaston investigated the constitution of elastic fluidity in a manner worthy of his genius, and had shewn, that "all the phenomena accord entirely with the supposition that the earth's atmosphere is of a finite extent, limited by the weight of ultimate atoms of definite magnitude, *no longer divisible by repulsion of their parts* *." It hence appears that air, not "held together by pressure, would (*not*) probably separate to immeasurable distances."

"Cohesive affinity," says Dr. Henry, "is in solids proportionate to the mechanical force required for effecting their disunion." He should here have distinguished between hardness and tenacity. He should likewise have bestowed at least a wooden cut or two on Häüy's theory of crystallization; for want of which his account of the matter must merely perplex the student. The term *reflecting*, however appropriate to the inventor of the goniometer, is not the correct one for the instrument itself, which was originally named *reflective*.

In section 3, of the chapter on Chemical Affinity, Dr. Henry treats of the proportions in which bodies combine, and of the atomic theory †.

* On the finite extent of the atmosphere. Read at the Royal Society. January, 17, 1822.

† As persons, otherwise clear-headed and well-informed, are continually expressing their inability to comprehend this part of chemistry, we shall endeavour to divest it of rigmarol, and to shew them that it is a branch of chemical theory founded upon a very few and simple facts, which when once in their possession, will enable them not merely to understand its principles, but to appreciate its usefulness and importance. If we subject any true chemical compound to analysis, we shall find that its elements are always in the same proportions, and that from whatever source it be derived, or under whatever circumstances it be formed, they uniformly exhibit the same relative proportion to each other. Water, for instance, is a compound of hydrogen and oxygen, in which the former always bears to the latter, the proportion of 1 to 8. In dry sulphate of magnesia or Epsom salt, the sulphuric acid is to the magnesia uniformly as 40 to 20. Pure white marble, whether it comes from Paros

" 3dly. There are many examples in which bodies unite in one proportion only; and in all such cases, the proportion of the ele-

or from Carrara, or from the Pentelic hill, or from Sutherlandshire, or from any other part of the world, is composed of 28 parts of lime united to 22 of carbonic acid: and again 22 parts of carbonic acid, whether extracted from the said marble, or generated by the respiration of animals, or by the combustion of coal or wood, or of the diamond, whether poured forth from the surface of fermenting liquors, or issuing from fissures in the earth, consist in all cases of 6 parts of carbon combined with 16 of oxygen. But it often occurs that bodies combine in more than one proportion, and this happens to be the case with carbon and oxygen, which besides carbonic acid produce carbonic oxide. Now in respect to the latter, if we still suppose the weight of carbon to be 6, that of oxygen is 8, that is just half the quantity existing in carbonic acid; and as on the one hand we find the proportions of the elements of the same compound always in the same relation to each other; so when one substance combines with another in different proportions, to form different compounds, the numbers representing the greater proportions, are exact simple multiples of that denoting the smallest proportion. This doctrine of multiples is of so much consequence that we shall press another instance or two upon the attention of our uninitiated readers. There are two oxides of mercury, the black and the red; in the former 200 parts of the metal are united to 8, and in the latter to 16 of oxygen. There are 5 compounds of nitrogen and oxygen, and if we assume the weight of the nitrogen to be 14, that of the oxygen in the several compounds is respectively 8, 16, 24, 32, and 40; that is, one, two, three, four, and five times 8. So much for the doctrine of multiples. To explain another term used in these disquisitions, let us go back to the marble and Epsom salt. In the former we have discovered 22 parts of carbonic acid united to 28 of lime, forming 50 of carbonate of lime or marble, and in the latter we find 40 of sulphuric acid combined with 20 of magnesia, producing 60 parts of sulphate of magnesia or Epsom salt. If we now suppose these elements differently arranged, forming, for instance, carbonate of magnesia and sulphate of lime, we shall find them obedient to the same proportions, that is, 22 of carbonic acid will unite to 20 of magnesia to form 44 of carbonate of magnesia; and 40 of sulphuric acid will be required by 28 of lime to form 68 of sulphate of lime. Hence it is that the numbers which we have employed to represent the combining weights of the above substances have been termed *equivalent numbers*. If we now draw out a list of commonly occurring elementary or compound bodies, and affix numbers to them representing the smallest proportions in which they combine, in reference to some substance assumed as unity, it is obvious that such a list will present much useful information; for instance,

Hydrogen . . .	1	Lime	28
Oxygen	8	Soda	32
Water	9	Phosphoric acid	28
Sulphur	16	Nitric acid . .	54
Sulphuric acid .	40	Potassa . . .	48
Magnesia . . .	20		

Now from this table it will be manifest that 9 parts of water consist of 1 hydrogen and 8 oxygen. That 16 parts of sulphur combined with 24 (that is, 3 times 8) of oxygen constitute 40 of sulphuric acid; and that 40 of sulphuric acid will neutralize 20 of magnesia, 28 of lime, 32 of soda, and 48 of potassa, whereas the same weight of these alkaline substances will be neutralized by 54 of nitric acid, and by 28 of phosphoric acid. But whilst proceeding with these lucubrations we had almost forgotten the excellent illustrations of the uses and applications of such a system of numbers which Dr. Wollaston has annexed to his description of his *logometric scale of chemical equivalents*, published in the *Philosophical Transactions* for 1814, to which we refer our readers as infinitely luminous, and as rendering any extension of our remarks unnecessary.

ments of a compound, must be uniform for the species. Thus hydrogen and oxygen unite in no other proportions than those constituting water, which by weight are very nearly $11\frac{1}{2}$ of the former to $88\frac{1}{2}$ of the latter, or 1 to $7\frac{1}{2}$." In his preface he says, "Every new edition must reject whatever recent experience has proved to be erroneous." Now there are two very remarkable errors in the above sentence. 1, Hydrogen and oxygen were shewn several years ago by Thenard to unite in other proportions than those constituting water; and 2, The proportions constituting water are known to be not 1 to $7\frac{1}{2}$ but 1 to 8. Chlorine and hydrogen would have furnished Dr. Henry with a much better illustration of a definite solitary combination of two elements.

The third section of the chapter on affinity is devoted to the *atomic theory*. Aware of the familiar and daily intercourse which Dr. Henry enjoys with Mr. Dalton, to whom, indeed he dedicates his work, we naturally looked for a more elaborate and consistent exposition of this fundamental subject, than he has given. We regret also to observe that the name of Richter is suppressed, though his labours were directed to the doctrines of chemical equivalents, for some years before Mr. Dalton was known even to have thought on the subject; and though Richter furnished the only rigid method of discovering the atomic weights of neutral saline bodies. As to Sir H. Davy's ideas on chemical combination, they are evidently (we do not say intentionally) misunderstood by Dr. Henry. "Sir H. Davy," says he, "has assumed with Mr. Dalton, the atom of hydrogen as unity; but that philosopher, and Berzelius, also have modified the theory, by taking for granted that water is a compound of one proportion (atom) of oxygen, and two proportions (atoms) of hydrogen." We do not know where Dr. Henry has learned this. Sir H. Davy says, "As two volumes of hydrogen to one of oxygen enter into the composition of water, the ratio of the hydrogen in water will be to the oxygen as two to fifteen; and it may be regarded as composed of two proportions of hydrogen, and one of oxygen; and the number representing hydrogen will be 1, and that representing oxygen, 15*." Again, "Mr. Higgins has supposed that water is composed of one particle of oxygen, and one of hydrogen, and Mr. Dalton of an atom of each; but in the doctrine of proportions derived from facts, it is not necessary to consider the combining bodies either as composed of indivisible particles, or even as always united one and one, or one and two, or one and three proportions. Cases will hereafter be pointed out, in which the ratios are very different; and at present, as we have no means whatever of judging either of the relative numbers, figures, or weights of those particles of bodies which are not in contact, our numerical expressions ought to relate only to the results of experiments†." Hence Sir H. Davy's pro-

* *Elements of Chim. Phil.* p. 112. † *Ibid.* p. 114.

portional numbers are those given by experiment, of which the lowest ratio is one *volume* of hydrogen. But what must excite peculiar astonishment in every individual who has studied with any care the principles of reciprocal and multiple combination, is the manner in which Dr. Henry here speaks of Gay-Lussac's theory of volumes, which is, in truth, a legitimate corollary from the atomic theory itself. "In some instances, as in that of water, this law (of gaseous volumes) is not inconsistent with the atomic theory; *but in other instances it cannot be reconciled with the relative weights assigned to the atoms of certain elementary bodies.* In nitrous gas, for example, which Mr. Dalton conceives to be formed by the union of one atom of oxygen with one atom of nitrogen, equal volumes of these gases would give for the relative weights of oxygen and nitrogen, numbers widely differing from those derived by other methods. The *two hypotheses* of atoms, and of volumes, cannot, therefore, both be true; and from some well ascertained exceptions to the latter, it appears to me that the theory of volumes will scarcely be found tenable*."

We really were astonished at this passage, in the *ninth* edition of a book, of which the author says, "no pains has been spared to render these volumes a *faithful* abstract of the present state of chemistry." It is an indisputable fact that nitrous gas is constituted by the union of one volume of oxygen, and one volume of nitrogen, which, retaining their total bulk after combination, afford a compound gas, of mean specific gravity. It is another fact, equally indisputable, that nitrous oxide is constituted by the union of two volumes of nitrogen, and one of oxygen, which suffer a condensation equal to the volume of oxygen; whence the gas has a corresponding increase of specific gravity. In the first, the comparison of the weights of equal volumes, gives the ratio of oxygen to that of nitrogen as 16 to 14; or 2 atoms to 1 on Dr. Henry's scale. In the second case, the same comparison gives the ratio of 8 to 14, or of 1 atom to 1, on the same scale. Here, therefore, is a perfect accordance between the atomic *hypothesis*, and the *theory* of volumes.

But to examine the *hypothesis* a little more minutely: Let us assume a volume of oxygen so small as to contain only one atom; call its relative weight 16; then it will require for saturation, two such volumes of hydrogen, whose weight will be 2. Next assume a volume of nitrogen equal to the above volume of oxygen. It will contain one atom, and have a relative weight of 14; which will require for saturation three such volumes of hydrogen. But three such volumes are impossible, because they imply the bisection of Mr. Dalton's radical and primary atom, which is absurd.

The *general fact* of volumes requires no such mystifications, as the Daltonian *hypothesis* does. In saying so, we do not mean in

the slightest degree, to disparage Mr. Dalton's great merit in establishing, so ably as he has done, the important system of reciprocal and multiple combination. We wish merely to see it stripped of all such trappings as disguise and disfigure it. Among these, the following two positions of Mr. Dalton, expounded by Dr. Henry, may be reckoned. 1. *That an increase of the density of a gas, indicates an increased number of simple atoms, associated in the compound atom.* 2. "Moreover, it is *universally* observed that of chemical compounds, the most *simple* are the most difficult to be decomposed; and this being the case with carbonic oxide, we may naturally suppose it to be more simple than carbonic acid*." Dr. Henry clenches the first position as follows:—"It would be absurd to suppose carbonic acid, which is the heavier body, to be only *once* compounded, and carbonic oxide, which is the lighter, to be *twice* compounded†"

The first position goes to prove that nitrous oxide, a denser gas than nitrous gas, has an increased number of simple atoms, or is more than once compounded. Such is Mr. Dalton's own decision in this very case. The nitrous gas being the lighter, is the simpler body, or is only *once* compounded.

By the second position, however, nitrous gas is *not* the simpler body, but is *more* than once compounded, for it is decomposable by a great many substances which have no effect on nitrous oxide; such as moistened iron or zinc filings, muriate of tin, alkaline sulphites, and aqueous solutions of sulphurets. Thus nitrous oxide is "the most simple, as it is the most difficult to be decomposed." But by the first Daltonian article, it is the *most compounded*, or least simple; which is absurd. We shall leave the framer and expositor of these fancied axioms, to assist each other in getting off the horns of the dilemma at their leisure.

We felt, we must confess, a little alarmed when we first heard Doctor Henry talk so boldly of the "well-ascertained exceptions" to the *hypothesis* of volumes, which were to render "the *theory* of volumes scarcely tenable." But on hunting after his exceptions with some curiosity, we could not find one of them forthcoming in his two volumes. Truly, if the theory of volumes, as developed by Gay-Lussac, shall be found scarcely tenable, we know of nothing in chemical science to which we can venture to attach the anchor of our belief, for nothing is better demonstrated than that theory.

In the above instances our author has merely mistaken the partial enactments of his ingenious friend, for the laws of nature. But we shall see him presently enlist his ideas in foreign service, and advance doctrines incompatible with the principles of his English master, while he fondly imagines himself the true defender of the faith.

In section 5th, speaking of Berthollet's doctrines of affinity, he very properly quotes Professor Pfaff's experiments, to prove that

* Henry's *Elem.* I. 50.

† *Ibidem*, loco citato.

"in various cases, when two acids are brought into contact with one base, the base unites with one acid, to the entire exclusion of the other." Dr. Henry might have also adduced the mutual precipitation of metals from their saline combinations, in which the displacement is complete, and not partial, as Berthollet's doctrines lead us to infer, when the force of cohesion is equally active. Yet Dr. Henry, in his eighth section, entitled *Experimental Illustrations of Chemical Affinity*, seems to lose sight of what he had previously propounded; for he prints the following axiom in italics as one to be illustrated by experiment. "XIV. IN EVERY INSTANCE, in comparing the affinities of two bodies for a third, a weaker affinity in one of the two compared will be found to be compensated by increasing its quantity." We should like to know what quantity of silver or of oxalic acid may be requisite to decompose an ounce of sulphate of lead.

Dr. Henry's third chapter is dedicated to Caloric. The facts, which are distributed into four sections, appear to be well selected, and fairly stated. In describing M. Breguet's thermometer, in the second section, he appears to misunderstand its construction. "It consists," says he, "of a slip of silver, and another of platinum, coiled into a spiral, one end of which is fixed, while the other is connected with an index, which traverses a graduated circular plate." There is only one slip, in which the platina and silver are united face to face with gold solder. The difference of expansion between the two metals by variation of temperature, causes the spiral to increase or diminish the degree of its curvature, and thus makes the needle traverse the graduated circle, attached at right angles to the axis of the spiral.

The 4th Chapter treats of light, the phenomena of the prismatic spectrum, solar phosphori, &c.; and in the 5th we have brought before us the important subject of "the chemical agencies of common and galvanic electricity," a title which would have pleased us better, had the words "common and galvanic" been omitted; but this is a trifle, and the chapter itself a very good one; it treats in successive sections of the construction of galvanic apparatus, of the identity of galvanism and common electricity; of the chemical agencies of electricity; of the theory by which they are best explained; of the hypothesis of the origin of electricity in galvanic arrangements, and of the phenomena of electro-magnetic motion: upon a few of the topics discussed in this chapter, we must beg leave to offer a few observations.

And in the first place, we should advise our author in his next edition, entirely to re-model the first section, in which we are brought at once to the discussion of simple galvanic circles, and compound galvanic circles, without a word of prefatory matter respecting the laws of electrical excitation, and the new properties which bodies acquire whilst under its influence; we should also

recommend him to erase the second section, and to enlarge and extend the third, illustrating it by a few wood-cuts of the apparatus there referred to. The fourth section entitled "*Theory* of the changes produced by (galvanic) electricity;" and the fifth, on the theory of the action of the galvanic pile, touch upon some very intricate and abstruse parts of chemical reasoning, but upon which no very satisfactory or luminous conclusions have as yet been arrived at. We are generally led to regard bodies as endowed with certain inherent or natural electrical states, which render them either attractive of each other, or of surfaces oppositely electrified; we consider these opposite electricities as partially or entirely annihilated by combination, and to this source we *may* refer that remarkable extrication of heat and light, which so commonly announces intense chemical action. We *may* account for the destruction of common chemical attraction between two bodies, by supposing one of them to have an electrical state opposite to its natural one conferred upon it; while by exalting the natural electrical energies, we *may* explain their increased tendency to union. But all these assumptions are purely hypothetical, and still more so are those which our author has adduced in reference to the action of the pile, that is, to the source of its electricity. When we know what electricity is, we may presume to talk upon these matters, but at present we must rest content with a knowledge of facts and effects, and our stock must be infinitely and diligently multiplied before we can presume to determine upon the source of electricity, either in the common machine, or in the pile of Volta.

The sixth section gives a succinct and tolerably correct account of the most important electro-magnetic phenomena, in which, however, hypothesis and facts are rather too indiscriminately blended; and although we have great respect for Messrs. Arago and Ampere, we think they have indulged in electro-magnetic speculations, which border upon absurdity. Our information upon this very curious subject is extremely limited, and we do not hesitate to ascribe to the researches of Oersted, Davy, Wollaston, Faraday, and Siebeck, all that has really and actually been acquired in respect to it. The grand and important fact that a metallic wire, through which a current of electricity is passing, affects a magnetic needle, we owe to M. Oersted. Let us imagine a wire of platinum placed in the magnetic meridian, and a delicately-suspended magnetic needle underneath, near and parallel to it; in this state of things nothing particular will happen either to the wire or the needle: let us now connect the extremities of the wire with a voltaic battery, the right-hand extremity being in contact with the last zinc plate and the left-hand end with the last copper-plate, so that in the hypothetical language of electricians, a current of electricity may traverse the wire from the right to the left. Under these circumstances the magnetic needle will no longer remain pointing N. and

S., or in the magnetic meridian, but will be suddenly diverted from its natural position and place itself at right angles to the wire, its northern extremity becoming somewhat elevated, and its southern depressed. If we now reverse the direction of the electric current, we shall at the same time reverse the position of the needle; its south end will veer round to the spot formerly occupied by the N., and *vice versa* in regard to its north end. From this statement we may in some measure anticipate what would happen, when the wire is placed vertically instead of horizontally, in respect to the needle,—but we shall not enter into the details of position, least we perplex the main argument. For all this and much more important information connected with it, we are indebted to Professor Oersted. It might have been expected that a wire, under the influence of common electricity, would affect the needle in the same way as the galvanic conductor; Sir H. Davy instituted experiments which proved this to be the case, and he showed that to communicate strong and permanent polarity to a steel bar, it became necessary to attach it *transversely* to the electrified wire, or to place it in that position at a small distance from it. His researches led him moreover to a number of curious facts connected with the communication of magnetism by electricity, and his paper is full of curious suggestions connected with this inquiry*.

We now come to Dr. Wollaston, who, upon hearing of Oersted's discovery, immediately proceeded to convince himself of its correctness, and to examine into the theory of the phenomena; the result of his inquiries led him to infer, if we mistake not, that a current or vortex of magnetism was put into motion round the axis of the conducting wire, consequently, that no fixed magnetic poles could be observed; but that the pole of a magnet, on approaching the conducting wire, would cause it to attempt to revolve upon its own axis, in a direction dependent upon that of the electric current. Hence, the idea of magnetic rotation, which has since given rise to such an amusing multiplicity of apparatus, certainly first occurred to Dr. Wollaston; but having established his very ingenious and satisfactory theory, and having convinced himself and most of his friends, of its adequacy to the explanation of the phenomena, he seems to have dropped the inquiry, which in respect to rotation was pursued upon other grounds by Mr. Faraday, who constructed the first apparatus in which the pole of a magnet was made to revolve about the axis of a wire-transmitting electricity. In relation to this subject, we refer our readers to his papers in this Journal†, and to his "Historical statement respecting Electro-magnetic Rotation.†"

In the course of last year Dr. Siebeck of Berlin, showed that the electricity excited by heating compound metallic bars, might be rendered evident by its effect upon a magnetic needle, and Messrs.

* *Phil. Trans.* 1821.

† Vol. xii. p. 74 and 416.

‡ Vol. xv. p. 238.

Fourier and Oersted have extended these researches, and developed a series of very interesting phenomena, connected with the generation of electricity in metallic bars by change of temperature. These circuits they call *thermo-electric*, in opposition to the common galvanic arrangements which they properly enough term *hydro-electric*. Some details of the experiments will be found in a former Number, under the head of *Foreign Science**.

Chapter 6th. On the electro-negative bodies, oxygen, chlorine, iodine, and fluorine, is clearly and candidly drawn up. The next, great division contains the electro-positive bodies, subdivided into groups, each of which occupies a chapter.

Chapter 7th is entitled, "Of simple acidifiable bodies, (not metallic,) and their combinations with oxygen, chlorine, iodine, and fluorine." Here we have the usual six bodies, hydrogen, nitrogen, charcoal, boron, phosphorus, and sulphur, to which he has added selenium. We cannot approve of the single term *acidifiable* applied to characterize the above bodies. Nitrogen and hydrogen may as properly be styled alcalifiable bases, as acidifiable; for they form ammonia. And when hydrogen combines with chlorine, we may regard the chlorine as the acidifiable base, as well as the hydrogen. Dr. Henry should have contented himself with the title electro-positive bodies (non-metallic,) which involves no hypothesis, and to which no objections can be urged. The metals, on account of their number, may indeed, be conveniently subdivided into such as afford alkalis, earths, oxides, and acids. The details of this chapter merit equal praise to that which we have bestowed on the preceding. Under the compound of hydrogen and nitrogen (ammonia) he has introduced the salts formed with this alkali, and the acids he had previously described. The reasons which he assigns for this insulation of the ammoniacal salts among the non-metallic electro-positives, and their compounds, do not appear to us satisfactory.

Chapter 9th contains the metals with their oxides, chlorides, iodides, and the combinations of the oxides with the previously described acids, or the salts. His details appear to be correct, and as minute as the size of his work would admit.

It is in the general discussions or philosophy of chemistry that Dr. Henry seems to be least at home. Thus in the introductory section on the general properties of metals, we find him retailing as important special laws, propositions which have been long ago merged into the great system of chemical equivalents, of which they constitute particular corollaries. Indeed one of the general principles advanced by Dr. Henry, is manifestly no general principle at all, as we shall presently see.

That the quantity of acid which different metals require for saturation is in direct proportion to the quantity of oxygen in their

* Vol. xv. p. 126.

oxides was an important fact, when M. Gay-Lussac first announced it in the second volume of the *Mémoires D'Arcueil*. But a single glance at Dr. Wollaston's scale shews that fact to be merely one particular aspect of the doctrine of equivalents; and Dr. Henry should have therefore traced it to its source. The greater the proportion of oxygen in a protoxide, the nearer does its atomic weight, or equivalent, stand to the beginning of the scale, and of course, the greater its saturating ratio. Thus, as 100 of lead take 7.7 of oxygen to form litharge, while 100 of mercury take 4 to form the black oxide, the former will take a quantity of acid compared to the latter, as 7.7 to 4; for $7.7 : 4 :: 25 : 13$; that is, the proportions of oxygen in protoxides are invariably as the atomic weights of the metals; and the less the atomic weights, the less of them is requisite to saturate a given portion of any acid.

"It has been deduced," says Dr. Henry, "by Berzelius, as a general principle, from the comparison of a great number of facts, that in all neutral salts, the oxygen of the acid is a multiplication of that of the base, by some entire number." The law he apprehends, may be expressed more generally in the following terms: *When two oxidated substances enter into a neutral combination, the oxygen of that which, in a galvanic circle, would be attracted to the positive pole, is a multiplication by an entire number of the oxygen of that which would be deposited at the negative pole.* The chemical associate of Mr. Dalton should have known that this is neither a general principle, nor a just proposition. The particular facts in unison with it, which originally misled Berzelius, are those exhibited in the union of acids, containing two or three atoms of oxygen, with bases containing only one. So far the thing is plain. Thus sulphuric acid contains three proportions of oxygen, and will hence afford a threefold multiple, (not multiplication,) of oxygen, in its combinations with all the protoxides. But in some of its combinations with the deutoxides, this fancied law is no longer applicable, but would lead to serious errors. For in them, the ratio of oxygen in the acid, is not unfrequently to that in the base, as 3 to 2 or $1\frac{1}{2}$ to 1. Again, those acids which contain two atoms of oxygen, will not, in their compounds with bases also containing two atoms, give a multiple, but an equal proportion of oxygen. Anhydrous carbonate of copper is in this predicament. If again we consider those acids which contain only one atom of oxygen, as the phosphorous, the oxygen will be either a *sub-multiple* of that in the bases, or equal to it in quantity, according as it is combined with a deutoxide or a protoxide. This is also the case with the hyposulphites. Finally, with regard to some of the nitrates, and chlorates of deutoxides, the relation of oxygen in the acids, will be to that in the bases as 5 to 2. In the subnitrate of copper, this relation is as 5 to 4, a proportion which places in a striking point of view the absurdity of Berzelius's law. If we excuse him on account of the early period when

it was promulgated, before the theory of equivalents was properly developed, what defence can Dr. Henry offer, for incorporating it in his systematic compilation of 1823?

Another supposed law of Berzelius' which Dr. Henry calls important, is enunciated as follows: "*The quantities of different bases required to saturate a given quantity of any acid, all contain the same quantity of oxygen.*" This is our old friend with a new face. Let any one take up Dr. Wollaston's scale, and slide any number opposite to a given acid, it is obvious that the number opposite oxygen is the equivalent to all the protoxide bases in the list. By taking such partial views, we may fabricate as many canons as we please.

In his general discussion on metallic alloys, Dr. Henry says, "To estimate exactly, however, either the increase or diminution of density, requires an attention to several circumstances." He then refers in a foot note to Aikin's dictionary, article *Alloy*. Is not Dr. Henry aware that the rule given in that respectable work, for computing the mean density of an alloy, is a false one, and leads to very erroneous results?

We cannot approve of his systematic arrangement of the metals, which he has indeed copied from Thenard, along with several tables. His two general classes of the metals have been long received; the oxides of the first class are not reducible by heat alone, those of the second are. The first class has three subdivisions. 1. "*Metals that are either known from experiment, or believed from analogy, to absorb oxygen, at high degrees of heat, and to decompose water at common temperatures.*" Here are placed the 6 metals, potassium, sodium, lithium, calcium, barium, and strontium. Those presumed by analogy to belong to this subdivision, are the metallic bases of the earths proper. 2. "*The second subdivision includes those metals which absorb oxygen from atmospheric air at high temperatures, and decompose water, but NOT UNDER a red heat.*" These are 5 in number, viz., manganese, zinc, iron, tin, and cadmium. 3. "*Metals of the third subdivision are capable, like the foregoing, of absorbing oxygen at high temperatures, but not of decomposing water at any temperature.*" Here we have 14 metals, out of Thenard's 15, Dr. Henry having transferred nickel to the 2nd class of noble metals.

We beg leave to remark, that the metals of the first subdivision absorb oxygen, not merely at high degrees of heat, **but** at ordinary temperatures. Potassium and sodium, tarnish and oxidize speedily in dry air. Their characteristic property is to decompose cold water with explosive violence. The metals of the second subdivision are not truly represented by Dr. Henry, when he says, "they absorb oxygen from the air, at high temperatures, and decompose water, but not under a red heat." We shall give him three authorities for our opinion, which he will not venture to gainsay. "* Manganese, when exposed to the air, attracts oxygen

* Thomson's System of Chem. 6th Edit. I. 416.

with considerable rapidity. When thrown into water, it decomposes that liquid, with considerable rapidity."

"By exposure to the air for some time, zinc acquires a greyish colour on the surface, which is owing to a partial oxidizement. Zinc filings very slowly decompose water, hydrogen gas is evolved, and oxygen combines with the metal *."

"A temperature of, from 120° to 140° Fahr., renders water decomposable by iron, especially when the metal bears a considerable proportion to the water†."

We apprehend that the arrangement of the metals, best adapted for students, would be to begin with the alkalifiable, next to proceed to the geofiable, whereby a knowledge of the alkaline and earthy re-agents, so useful in metallic research, would be acquired at the outset. So far our plan agrees with Dr. Henry's. The ordinary metals might then be examined as nearly as possible in the order of their affinities for oxygen, terminating the list with platinum, and its companion metals. The old distinctions of metals, and semi-metals, perfect and imperfect, base and noble, should be for ever banished from chemical discourse. They are all the perfect and noble productions of nature, and the multiplication of their species is one of the chief achievements of modern science.

We have looked over our author's 10th and 11th chapters on vegetable substances, and their decomposition, as well as the 12th, on animal substances, and the 13th on animal products. We think that the facts are judiciously abridged, and fairly stated. The 14th chapter on chemical analysis is divided into 3 sections; of which the first treats of gaseous analysis, the second of that of mineral waters, and the third of that of minerals. In these details, he has followed Thenard and other writers on analysis with fidelity. We could have wished him to have been a little less sparing of references to the works from which he has borrowed. "Nothing," says poor Richard, "gives an author so great pleasure as to find his works respectfully quoted by others."

In the preceding article we have diligently exposed what to us appear the prominent errors and principal failures in Dr. Henry's book, in the hope that our remarks may influence the merits of his tenth edition, and in the belief that he will not be offended with the freedom of our strictures. In conclusion, we must add that there is very much more to praise than to censure, in this work; in matters of detail it will furnish a valuable guide to the chemical student, and will uphold the reputation of its author, as a candid and careful compiler, who speaks of his own inquiries without egotism, and who discusses controverted, abstruse, and uncertain points, with that becoming diffidence and candour which shows him (with the Daltonian exceptions above-named) "nullius addictus in verba magistri."

* *Sir H. Davy's Elements*, 374.

† *Henry's Elements*, 9th Edit. II. 17.

ART. XVII. ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XVI.

i. *Description of a New TIDE GAUGE.*

It is proposed to fix a pipe, with an open mouth, and a triangular orifice (Δ) at its side, in contact with any convenient part of a bridge or pier that is situated below low-water mark, and to bring from it a pipe, resembling those which are used for the distribution of gas, into any room of a neighbouring house, that may be chosen for the purpose of observation, and there to let it terminate in a well closed reservoir, provided with a little forcing syringe, and with an open barometer gauge, to which a manometrical gauge may be added, if required.

Immediately before each observation, it will be proper to work the syringe, until the gauge becomes stationary, by the escape of the air under the water, so that the column of compressed air may always begin from the level of the upper angle of the triangular orifice; the height of the gauge will then obviously indicate the height of the surface of the water above this level. It would only be necessary, if the height of the reservoir above the orifice were considerable, to apply a small correction for the excess of the weight of the air in the pipe, above a similar column of the external air; this correction being always additive. The gauge might have a double graduation, one for its own height, the other for that of an equivalent column of water.

Brighton, 22d Oct. 1823.

ii. *Catalogue of the ORBITS of all the COMETS hitherto computed.* By Dr. OLBERS and Professor SCHUMACHER. Astr. Abh. I.

(Concluded from page 151.)

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
71	70	1770	Aug. 13	h 13 5 0 11 26 16 26	s 4 12 0 0 3 7 14 16 26	s 7 14 16 26	0 1 33 40	0.674381	9.828906	0.216769	0.7857654	D	Lexell
			14	0 13 24 11 26 26 13	4 12 17 0 3 7 14 9 10	7 14 9 10	1 34 30	0.676893	9.830520	0.214348		D	Pingré
			9	0 32 48 11 26 12 50	4 16 14 0 4 12 0 0	7 9 58 50	1 45 20	0.628720	9.798457	0.262443		D	Slop
			9	3 38 0 11 25 57 0	4 12 0 0 4 12 0 0	7 13 57 0	1 55 00	0.631000	9.800029	0.260085		D	Lambert
			8	19 26 0 11 26 19 28	4 14 21 45 4 14 21 45	7 11 57 48	1 49 50	0.627575	9.797666	0.263629		D	Rittenhouse
72	71	1770	13	12 37 35 11 26 15 11	4 11 54 54 4 11 54 54	7 14 20 17	1 34 31	0.674360	9.828889	0.216794	0.7854736	D	Burckhardt
			13	12 39 43 11 26 16 38	4 11 52 46 4 11 52 46	7 14 23 52	1 33 50	0.674300	9.828833	0.216849	0.78554	D	idem
			Nov. 22	5 48 0 6 28 22 44	3 18 42 10 3 18 42 10	8 20 19 26 31	25 55	0.528240	9.792833	0.375879		R	Pingré
			Apr. 18	22 14 27 3 13 28 13	0 27 51 0 27 51 0	2 15 37 11	15 29	0.905760	9.957013	0.024609		D	idem
			19	0 39 31 3 13 48 21	0 27 49 37 0 27 49 37	2 15 58 44	16 44	0.901878	9.955148	0.028606		D	Prosperin
73	72	1771	19	5 10 42 3 14 2 54	0 27 50 27 0 27 50 27	2 16 12 27	11 16	0.903370	9.955864	0.026332	1.00944	D	Burckhardt
			19	4 25 36 3 13 57 52	0 27 56 16 0 27 56 16	2 16 1 36	11 15	0.9020537	9.955234	0.0272797		D	Encke
			19	5 15 40 3 14 3 16	0 27 51 55 0 27 51 55	2 16 11 21	11 15	0.9034632	9.9559204	0.0262477	1.0033698	D	idem
			Feb. 18	20 50 35 3 18 6 22	8 12 43 5 8 12 43 5	7 5 23 17	18 59	0.1018140	0.007807	9.948418		D	Lalande
			23	10 48 0 3 25 6 25	8 11 11 56 8 11 11 56	7 13 54 29	18 21	0.045640	0.019382	9.932055		D	Burckhardt
74	73	1772	20	3 3 0 3 20 6 0	8 12 25 54 8 12 25 54	7 7 40 6	18 51	0.1028120	0.012042	9.942066	0.903148	D	Bessel
			19	2 19 25 3 20 14 54	8 14 0 1 8 14 0 1	7 6 14 53	18 17	0.103590	0.005865	9.951330		D	idem
			9	5 0 0 3 0 17 0	8 21 9 0 8 21 9 0	6 9 8 0	20 28	0.891800	9.950270	0.034730	0.67692	D	Gauss
			8	1 0 0 3 7 21 0	8 23 24 0 8 23 24 0	6 13 57 0	17 39	0.911800	9.959900	0.020280		D	idem
			Sep. 5	11 18 45 2 15 35 45	4 1 15 37 10 4 1 15 37 10	14 20 8	61 25	0.1018140	0.054576	9.878264		D	Pingré
75	74	1773	5	17 9 2 2 16 10 26	4 1 20 0 10 4 1 20 0 10	14 50 26	61 30	0.11339	0.056965	9.874681		D	idem
			5	5 5 43 2 15 9 17	4 1 10 26 10 4 1 10 26 10	13 58 51	61 19	71.2155	0.051100	9.883478	0.9930752	D	Lexell
			5	5 55 0 2 15 15 50	4 1 12 11 10 4 1 12 11 10	14 3 39	61 20	571.124865	0.053115	9.880456	0.9951225	D	idem
			5	11 29 54 2 15 28 17	4 1 13 4 10 4 1 13 4 10	14 15 13	61 18	221.130095	0.054318	9.878651	1.0037085	D	idem
			5	14 11 11 2 15 17 0	4 1 8 20 10 4 1 8 20 10	14 8 40	61 15	111.133231	0.052961	9.880687	1.0024901	D	idem
76	75	1774	5	9 12 1 2 14 57 41	4 1 4 49 10 4 1 4 49 10	13 52 52	61 13	191.129694	0.051272	9.883220	0.9934997	D	Pingré
			5	14 43 9 2 15 10 58	4 1 5 30 10 4 1 5 30 10	14 5 28	61 14	171.12689	0.051881	9.863308		D	Burckhardt
			Aug. 14	4 20 0 10 16 27 57	6 0 57 26 4 6 0 57 26	4 15 30	81 82	47 40	0.153900	9.729278		D	Saron
			14	17 56 0 10 16 48 24	6 0 50 13 4 6 0 50 13	4 15 58	11 82	48 38	0.153900	9.729278		D	idem
			15	5 17 0 10 17 26 0	6 1 22 0 4 6 1 22 0	4 16 4	0 82	21 0	0.154121	9.728947		D	Boscovich
77	76	1775	10	55 35 10 17 22 4	6 0 49 48 4 6 0 49 48	4 16 32	16 83	0 25	0.154906	9.727769		D	Méchain
			14	12 0 0 10 16 38 0	6 0 54 0 6 0 54 0	4 15 44	0 82	48 0	0.153815	9.729406		D	Du Séjour

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
76	75	1774 Aug. 17	h 13 0 0 11 13 19 0	s 0 11 13 19 0	s 6 3 32 0	s 5 9 47 0	° 0 83 30 0	0.163460	9.714938			D	Bode
77	76	1779 Jan. 4	15 20 4 42 10 17 27 40	2 27 14 0	6 0 44 34	4 16 43	6 83 20	0.1562066	9.7258184	1.0282955		D	Burckhardt
		4	2 20 30	2 27 14 0	0 25 3 1	2 2 10 59 32	26 14 0	9.858222	0.178295			D	Saron
		4	2 12 0	2 27 13 11	0 25 5 57	2 2 7 14 32	24 0 0	9.858167	0.180378			D	Méchain
		4	2 24 30	2 27 13 40	0 25 3 57	2 2 7 14 32	25 30 0	9.853003	0.180324			D	D'Angos
		4	2 54 20	2 27 12 55	0 25 4 19	2 2 8 36 32	24 44 0	9.853057	0.180548			D	Reggia
		4	2 29 0	2 27 16 0	0 25 5 0	2 2 11 0 32	24 0 0	9.853516	0.179854			D	Oriani
		3	18 18 30	2 26 52 29	0 25 2 55	2 1 49 34	32 41 32	9.852811	0.180912			D	idem
		4	2 29 1	2 27 14 19	0 25 7 9	2 2 7 10 32	18 24 0	9.853220	0.178292			D	Prosperin
				2 27 18 22	0 25 9 20	2 2 9 23 15	6 0 7	9.853508	0.179866			D	idem
		4	4 21 23	2 27 18 44	0 25 8 23	2 2 10 21 32	16 56 0	9.853469	0.179925			D	idem
		4	2 13 41	2 27 14 27	0 25 4 10	2 2 10 17 32	30 57 0	9.853186	0.180349			D	Zach
		4	2 40 0	2 27 9 40	0 24 5 18	2 2 12 22 32	31 7 0	9.853160	0.180388			D	Pacassi
78	77	1780 Sep. 30	20 16 22	8 6 30 14	4 4 0	7 27 29	46 53 56	8.990371	1.474571			R	Lexell
		30	16 8 24	8 6 19 21	4 4 30	7 28 10	39 53 15	9.002026	1.457089			R	idem
		30	7 29 51	8 5 54 55	4 5 30	7 29 35	5 51 56	9.923826	1.421889			R	idem
		30	18 12 50	8 6 21 18	4 4 9 19	7 27 48	1 53 48	8.996755	1.464996			R	Méchain
79	78	1780 Nov. 23	19 0 0	2 5 7 0	5 1 48	9 3 19	0 84 15	9.526	0.671			D	Boscovich
		28	20 26 0	8 6 52 0	4 21 1	8 14 9	0 72 3	9.712041	0.892067			R	Olbers
80		1781 Jul y7	4 41 20	7 29 11 25	2 23 0 38	5 6 10	47 81 43	9.889884	0.125452			D	Méchain
81	80	1781 Nov. 29	12 42 46	0 16 3 28	2 17 22 52	2 1 19 24	27 13 8	9.982729	9.986034			R	idem
		29	12 42 46	0 16 3 7	2 17 22 55	2 1 19 48	27 12 4	9.982721	9.986046			R	idem
		29	12 42 46	0 16 3 7	2 17 22 55	2 1 19 48	27 12 4	9.982723	9.986046			R	Legendre
82	81	1783 Nov. 15	5 53 23	1 15 24 46	1 24 13 50	11 21 10	56 53 9	0.194598	9.66823			D	Méchain
		15	5 53 30	1 15 25 0	1 24 14 0	11 21 11	0 53 9	0.194606	9.668220			D	idem
		13	6 13 0	1 13 58 47	1 24 10 10	11 19 48	37 54 9	0.195175	9.667366			D	Méchain
		20	9 26	1 19 4 20	1 24 10 45	11 24 53	45 52 19	0.197881	9.663307			D	and
		Oct. 23		0 27 44 56	1 24 26 51	11 3 18	56 46 28	0.167876	9.708314			D	Saron
		Nov. 19	12 0 11	1 20 3 8	1 25 45 20	11 24 17	48 44 53	0.1626829	9.7161039	0.5395345		D	Burckhardt
		19	13 38 54	1 19 31 55	1 25 12 0	11 24 19	55 47 43	0.1747341	0.6980371	0.6784		D	idem
83	82	1784 Jan. 21	4 56 47	2 20 41 24	1 26 49 21	11 6 4	57 51 9	9.849946	0.185209			R	Méchain
		21	4 48 0	2 20 39 22	1 26 44 2	11 6 4	40 51 15	9.850131	0.184931			R	idem

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction	Name of the Computer.
84	84	1785 Jan. 27	h 7 58 4	s 3 19 51 56	s 8 24 12 15	s 6 25 39 41	° 170 14 12	1.143398	0.058198	9.872832		D	Méchain
85	85	1785 Apr. 8	11 29 0	9 27 34 40	2 4 44 40	4 7 10 087	7 0 0.427587	0.427587	9.631024	0.513592		R	Saron
86	86	1786 Jan. 30	20 34 0	5 6 38 0	11 4 8 0	6 2 30 0	13 36 0	0.32386	9.51056	0.69429	0.84836	D	Encke
87	86	1786 July 7	22 0 12	5 9 25 36	6 14 22 40	10 25 2	56 50 54	280.41010	9.612889	0.540735		D	Méchain
88	87	1787 May 10	19 58 0	5 8 38 30	6 15 23 32	10 23 14	58 50 58	330.39424	9.595763	0.566484		D	Reggio
89	88	1788 Nov. 10	7 35 0	9 7 44 9	3 16 51 35	3 9 7	26 48 15	510.34891	0.542714	0.646057		R	Saron
90	89	1788 Nov. 20	9 13 45	0 23 12 22	11 21 42 15	1 27 48	36 12 27	401.063012	0.026538	9.920321		R	Méchain
91	90	1790 Jan. 15	5 15 0	0 22 49 54	11 22 24 26	1 0 25	28 64 30	240.757313	0.026538	9.920391		D	idem
92	91	1790 Jan. 28	7 45 30	1 28 24 45	5 22 50 2	3 24 25	17 29 44	70.747336	9.879276	0.141215		D	idem
93	92	1790 May 21	5 56 15	9 3 43 27	1 3 11 2	3 29 27	35 63 52	270.797960	9.879725	0.140541		R	Saron
94	93	1792 Jan. 13	13 44 13	1 6 29 42	6 10 46 15	5 4 16	40 63 35	0.791005	9.873516	0.149854		R	idem
95	94	1792 Dec. 27	4 55 0	4 16 5 33	9 13 17 36	4 27 12	8 49 0	240.965812	0.026650	9.920153		D	Méchain
96	95	1793 Nov. 4	20 21 0	7 18 42 0	3 18 29 0	7 29 47	0 60 21	0 0.4034	9.901981	0.107156		R	idem
97	96	1793 Nov. 18	15 38 0	2 11 0 0	0 2 20 0	2 10 40	51 56 0	1.5045	9.898179	0.112859		R	Englefield
(86)	97	1795 Dec. 15	8 29 50	5 10 29 0	11 23 14	5 17 15	22 10	0.24379	0.111605	9.792719		R	Méchain
									0.111456	9.792814		R	Zach
									0.112164	9.791883		R	Méchain
									0.111195	9.793335		R	Englefield
									9.984893	9.982789		R	Méchain
									9.985350	9.982103		R	Piazz
									9.985106	9.982463		R	Prosperin
									9.985112	9.982460		R	Saron
									9.605736	0.551524		R	idem
									0.177392	9.694040		D	idem
									0.177388	9.694046		D	idem
									0.1461360	9.7409243	0.7347635	D	Burckhardt
									9.387016	0.879604		D	Olbers
									9.411620	0.842639		D	Bouvard
									9.352398	0.927181		D	Zach
									9.389538	0.875822		D	Olbers
									9.387408	0.879017		D	idem

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction.	Name of the Computer.
(86)	97	1795	Dec. 15	h 27 59 5 10 20 49 5 12 44 22	s 0 49 11 21 47 17 4 39 22	° 21 45 52 18 33 32 13 42 30	0.244539	9.3883480	0.8776063		D	Encke
98	98	1796	Apr. 21	10 44 22 6 12 44 13	11 4 39 22 0 17 2 16	2 1 58 13 4 18 36	0.334550	0.5244615	0.6734360	0.818828	D	idem
99	99	1797	July 9	19 55 6 2 40 31	10 17 2 16 8 10 29 15	6 4 18 36 9 48 29 50	0.57816	0.198151	0.662902		R	Obers
			10	9 16 0 2 53 52	1 19 27 8 10 29 15 37	9 5 33 0 9 41 48 50	0.52661	0.721489	0.3778946		R	idem
			9	16 0 19 34 42	1 1 40 0 10 29 16 30	9 5 33 0 9 41 48 50	0.463	0.66558	0.46176		R	Bode
100	100	1798	Apr. 4	11 15 51 3 14 59 0	4 2 9 0 4 2 12 21	11 12 50 11 12 54	0.52545	0.720531	0.379332		R	Bouvard
			4	12 7 37 3 15 6 57	4 2 12 21 4 2 12 21	11 12 50 11 12 54	0.484758	0.685527	0.431838		D	Olbers
101	101	1798	Dec. 31	22 5 15 1 3 35 5	8 9 30 2 8 9 30 4	7 5 54 57 7 5 0 16	0.484586	0.685372	0.432070		D	Burckhardt
			31	13 8 15 1 4 29 48	8 9 30 2 8 9 30 4	7 5 54 57 7 5 0 16	0.77479	0.889186	0.126349		R	Olbers
			31	13 26 24 1 4 27 27	8 9 30 4 8 9 30 4	7 5 0 16 7 5 0 16	0.77968	0.891917	0.122353		R	Burckhardt
102	102	1799	Sep. 7	6 46 49 4 34 20	3 9 15 21 3 9 33 38	7 5 3 3 7 5 3 3	0.77952	0.891829	0.122385		R	idem
			7	6 46 49 4 34 20	3 9 15 21 3 9 33 38	7 5 3 3 7 5 3 3	0.77952	0.925031	0.072582		R	idem
			7	5 6 30 0 3 38 16	3 9 33 38 3 9 33 38	3 5 57 34 3 5 49 22	0.83868	0.923596	0.074734		R	Méchain
			7	5 43 25 0 3 38 16	3 9 33 38 3 9 33 38	3 5 49 22 3 5 49 22	0.840003	0.924281	0.073707		R	idem
103	103	1799	Dec. 25	19 3 50 6 10 14 51	3 9 27 19 3 9 27 19	3 5 44 47 3 5 44 47	0.840178	0.924372	0.073571		R	Zach
			25	18 13 7 6 10 22 46	3 9 27 19 3 9 27 19	3 5 44 47 3 5 44 47	0.840305	0.924434	0.073477		R	Wahl
			25	21 40 10 6 10 20 12	3 9 27 19 3 9 27 19	3 5 44 47 3 5 44 47	0.840305	0.924434	0.073477		R	Olbers
104	104	1801	Aug. 8	13 0 0 6 10 20 12	1 12 8 1 12 8	4 16 7 32 4 16 7 32	0.62445	0.795498	0.266884		R	Wahl
			8	13 32 0 6 3 49	1 12 8 1 12 8	4 16 7 32 4 16 7 32	0.62445	0.795482	0.266904		R	Méchain
105	105	1802	Sep. 9	20 43 14 2 7 45 10	10 16 46 10 16 46	0 21 50 53 0 21 50 53	0.62580	0.796436	0.265474		R	idem
			9	21 32 29 2 9 4	10 16 46 10 16 46	0 21 50 53 0 21 50 53	0.62580	0.396200	0.865828		R	Burckhardt
106	106	1804	Feb. 13	14 16 16 4 28 44 51	5 26 47 58 5 26 47 58	1 56 53 56 1 56 53 56	0.2617	0.417804	0.833430		D	Méchain
			13	15 40 0 4 28 53 52	5 26 47 58 5 26 47 58	1 56 53 56 1 56 53 56	0.2617	0.039295	0.901186		D	Olbers
(86)	107	1805	Nov. 18	3 18 27 4 27 51 28	11 14 37 19 11 14 37 19	5 13 14 9 5 13 14 9	0.37862	0.039061	0.901537		D	Gauss
			17	19 20 39 4 27 17 0	11 14 37 19 11 14 37 19	5 13 14 9 5 13 14 9	0.37862	0.029858	0.915341		D	Bouvard
			18	0 25 0 4 29 0 28	11 15 6 56 11 15 6 56	5 13 53 32 5 13 53 32	0.37566	0.030308	0.914666		D	Wahl
			18	1 8 6 4 28 44 57	11 15 5 58 11 15 5 58	5 13 38 59 5 13 38 59	0.376236	0.081412	0.913010		D	Bessel
107	108	1805	Dec. 31	6 47 4 3 19 23 40	8 10 33 14 8 10 33 14	7 8 50 26 7 8 50 26	0.83176	0.578201	0.592826		D	Gauss
			21	12 9 11 5 6 47 24	4 20 11 6 4 20 11 6	6 2 27 13 6 2 27 13	0.84617529	0.53969	0.65059		D	Legendre
			21	12 9 11 5 6 47 24	4 20 11 6 4 20 11 6	6 2 27 13 6 2 27 13	0.84617529	0.574798	0.597931		D	Bouvard
			21	12 9 11 5 6 47 24	4 20 11 6 4 20 11 6	6 2 27 13 6 2 27 13	0.84617529	0.575461	0.596937		D	Encke
			21	12 9 11 5 6 47 24	4 20 11 6 4 20 11 6	6 2 27 13 6 2 27 13	0.84617529	0.5320165	0.6621035		D	Gauss

N.	Déclaire	Date.	Passage of the Perihelion in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direct or	Name of the Computer.
107	108	1806 Jan. 2	h 10 35 10	s 3 19 30 2	s 8 11 28 23	7 8 17 13 16 30 35 0	1 39 12 43 10 0	9.91786	9.959893	0.020289		D	Gauss
		1805 Dec. 31	6 19 27 3 19 23 13	8 10 34 42	7 8 47 13 16 30 35 0	8 17 13 16 30 35 0	1 39 12 43 10 0	0.89203	9.950379	0.034560	0.914307	D	Bessel
		31	18 39 36 3 19 23 39	8 10 34 42	7 8 35 8 15 36 10 0	8 15 36 10 0	1 39 12 43 10 0	0.89682	0.952702	0.031074		D	idem
		31	6 51 8 3 19 23 39	8 10 33 34	7 8 50 5 16 31 10 0	8 50 5 16 31 10 0	1 39 12 43 10 0	0.89181	9.950270	0.034723	0.679242	D	Legendre
		31	6 20 59 3 17 21 50	8 10 33 35	7 6 48 15 16 30 32 0	8 15 16 30 32 0	1 39 12 43 10 0	0.89193	9.950330	0.034633		D	Gauss
		31	8 41 18 3 19 28 54	8 10 31 34	7 8 57 20 16 35 9 0	8 16 35 9 0	1 39 12 43 10 0	0.891347	9.950047	0.034057		D	Bouvard
		31	5 46 43 3 19 23 29	8 10 33 20	7 8 50 9 16 31 27 0	8 16 31 27 0	1 39 12 43 10 0	0.8917974	9.9502662	0.0347290		D	idem
108	109	1806 Dec. 28	22 2 20 3 4 4 30	3 4 4 30	10 22 18 38	7 18 14 8 35 4 5 1	0.08193		0.034198	9.90883		R	Bessel
		28	22 30 43 3 7 2 3	3 7 2 3	10 22 19 15	7 15 17 12 35 2 50	1.081571		0.034055	9.909066		R	Burckhardt
109	110	1807 Sep. 18	18 56 0 9 0 56 53	9 0 56 53	8 26 39 40	0 4 17 13 63 14 10	0.647491		9.811234	0.243278		R	Bouvard
		18	19 6 0 9 0 13	9 0 13	8 26 38 31	0 4 21 42 63 12 36 0	0.64788		9.811493	0.242889		D	Gauss
		18	5 31 12 9 2 24 0	9 2 24 0	8 26 44 0	0 5 40 0 62 57 0	0.65320		9.8150	0.23763		D	Beck Calken
		18	19 49 9 0 53 38	9 0 53 38	8 26 29 25	0 4 24 13 63 16 15 0	0.647617		9.811316	0.243153		D	Brojelmann
		18	20 7 5 9 1 6 8	9 1 6 8	8 26 40 52	0 4 25 16 63 13 7 0	0.64846		9.811880	0.242298		D	Oriani
		18	15 15 51 9 0 51 5	9 0 51 5	8 26 42 12	0 4 8 53 63 12 51 0	0.646267		9.810412	0.244510		D	Ferrer
		18	17 28 50 9 0 45 1	9 0 45 1	8 26 39 9	0 4 5 52 63 12 30 0	0.646213		9.810376	0.244564		D	Lemeur
		18	11 44 26 9 0 55 5	9 0 55 5	8 26 40 26	0 3 25 29 63 17 14 0	0.646212		9.810376	0.244565		D	Triesnecker
		18	15 52 50 9 0 39 22	9 0 39 22	8 26 36 57	0 4 2 25 63 17 56 0	0.648123		9.811657	0.242613		D	Santini
		18	19 27 55 9 0 53 55	9 0 53 55	8 26 25 3	0 4 34 52 63 9 57 0	0.649620		9.812659	0.241140		D	Bowditch
		18	20 55 32 9 1 6 53	9 1 6 53	8 26 33 4	0 4 33 49 63 11 18 0	0.648769		9.812097	0.241983		D	Dan de Montf
		18	19 3 0 9 0 58 22	9 0 58 22	8 26 40 46	0 4 17 36 63 13 2 0	0.64746		9.811216	0.243305		D	Cacciatores
		18	19 51 7 9 1 6 8	9 1 6 8	8 26 36 52	0 4 29 16 63 14 28 0	0.64896		9.812217	0.241803	0.99503475	D	Bessel
		18	17 41 43 9 0 53 51	9 0 53 51	8 26 48 9	0 4 5 45 63 10 11 0	0.64587		9.810147	0.244908		D	idem
		18	17 53 20 9 0 54 42	9 0 54 42	8 26 47 12	0 4 7 30 63 10 28 0	0.6461238		9.8103158	0.2446546	0.99548781	D	idem
110	111	1808 July 12	4 10 49 8 12 38 50	0 24 11 15	7 18 27 35 39 18 59 0	0.60786			9.783870	0.284323		D	idem
111	112	1810 Oct. 5	19 54 11 2 3 9 10	10 8 53 4	3 24 16 6 62 46 17 0	0.96914			9.986385	9.980351		D	idem
112	113	1811 Sep. 15	10 9 54 21 2 14 48 14	4 19 0	1 0 47 30 71 50	1.2337			0.05450	9.675378		R	Burckhardt
		12	4 51 3 2 15 17 34	4 20 20 25	2 5 32 11 73 9 40	1.035679			0.015225	9.937290		R	Bessel
		12	0 21 9 2 13 14 35	4 21 4 59	2 5 6 39 73 7 16 1	0.040064			0.017060	9.934539		R	Gauss
		10	6 57 30 2 14 29 40	4 20 16 56	2 5 47 16 72 59 10	0.98069			9.99153	9.972833		R	idem
		12	6 57 30 2 14 29 40	4 20 16 56	2 5 47 16 72 59 10	1.02716			0.011638	9.942672	0.9919532	R	Flaugergues
		12	6 2 31 2 15 1	4 20 24 30	2 5 23 21 73 2 36	1.0354090			0.0151120	9.93746030	0.9954056	R	Bessel

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112	113	1811	Sep. 12	h 7 40 13 " 2 14 56 s 2 14 56	s 4 20 19 50 " 4 20 21 58 " 4 20 23 18	s 2 5 23 50 72 " 2 5 20 14 73 " 2 5 31 20 73	° 3 3 ' 4 31 " 3 44	1.03483 1.03539 1.03618	0.0152885 0.0151048 0.0154347	9.937197 9.9374711 9.9369764		R	Bouvard
			12	" 6 0 23 " 2 15 1 s 2 15 1	" 4 20 23 18 " 4 20 23 46 " 4 20 21 40	" 2 5 31 20 73 " 2 5 29 22 73 " 2 5 16 57 73	" 3 44 ' 3 28 " 4 18	1.03618 1.0362 1.036406	0.0154347 0.0154432 0.01530	9.9369764 9.9369639 9.936833		R	Nicolai
			12	" 9 19 1 " 2 14 51 58 s 2 14 51 58	" 4 20 23 18 " 4 20 23 46 " 4 20 21 40	" 2 5 31 20 73 " 2 5 29 22 73 " 2 5 16 57 73	" 3 44 ' 3 28 " 4 18	1.03618 1.0362 1.036406	0.0154347 0.0154432 0.01530	9.9369764 9.9369639 9.936833		R	Piazzi
			12	" 9 15 18 " 2 14 54 24 s 2 14 54 24	" 4 20 23 18 " 4 20 23 46 " 4 20 21 40	" 2 5 31 20 73 " 2 5 29 22 73 " 2 5 16 57 73	" 3 44 ' 3 28 " 4 18	1.03618 1.0362 1.036406	0.0154347 0.0154432 0.01530	9.9369764 9.9369639 9.936833		R	Calandrelli
			12	" 5 2 21 " 2 15 4 43 s 2 15 4 43	" 4 20 23 18 " 4 20 23 46 " 4 20 21 40	" 2 5 31 20 73 " 2 5 29 22 73 " 2 5 16 57 73	" 3 44 ' 3 28 " 4 18	1.03618 1.0362 1.036406	0.0154347 0.0154432 0.01530	9.9369764 9.9369639 9.936833		R	Gauss
			12	" 6 19 53 " 2 15 0 34 s 2 15 0 34	" 4 20 23 18 " 4 20 23 46 " 4 20 21 40	" 2 5 31 20 73 " 2 5 29 22 73 " 2 5 16 57 73	" 3 44 ' 3 28 " 4 18	1.03618 1.0362 1.036406	0.0154347 0.0154432 0.01530	9.9369764 9.9369639 9.936833		R	Argelander
			12	" 6 1 17 " 2 15 0 0 s 2 15 0 0	" 4 20 23 18 " 4 20 23 46 " 4 20 21 40	" 2 5 31 20 73 " 2 5 29 22 73 " 2 5 16 57 73	" 3 44 ' 3 28 " 4 18	1.03618 1.0362 1.036406	0.0154347 0.0154432 0.01530	9.9369764 9.9369639 9.936833		R	Conti
			12	" 8 37 6 " 2 14 55 6 s 2 14 55 6	" 4 20 23 18 " 4 20 23 46 " 4 20 21 40	" 2 5 31 20 73 " 2 5 29 22 73 " 2 5 16 57 73	" 3 44 ' 3 28 " 4 18	1.03618 1.0362 1.036406	0.0154347 0.0154432 0.01530	9.9369764 9.9369639 9.936833		R	Oriani
113	114	1811	Nov. 9	h 5 52 47 " 1 16 10 50 s 1 16 10 50	s 3 2 57 11 " 3 2 53 9 10 " 3 2 53 9 10	s 110 13 13 49 31 " 110 14 39 131 " 110 14 39 131	° 29 28 ' 53 " 53	1.58533 1.58892 1.58963	0.2001197 0.2011007 0.2012968	9.6599492 9.6584772 9.6581831		D	Werner
			11	" 4 46 1 " 1 17 32 10 s 1 17 32 10	" 3 2 53 9 10 " 3 2 53 9 10 " 3 2 53 9 10	" 110 14 39 131 " 110 14 39 131 " 110 14 39 131	° 53 ' 53 " 53	1.58892 1.58963 1.58963	0.2011007 0.2012968 0.2008271	9.6584772 9.6581831 9.6588876		D	idem
			11	" 13 9 14 " 1 17 47 0 s 1 17 47 0	" 3 2 53 9 10 " 3 2 53 9 10 " 3 2 53 9 10	" 110 14 39 131 " 110 14 39 131 " 110 14 39 131	° 53 ' 53 " 53	1.58963 1.58963 1.58963	0.2012968 0.2008271 0.2009477	9.6581831 9.6588876 9.6587067		D	idem
			11	" 4 30 17 " 1 17 29 30 s 1 17 29 30	" 3 2 53 9 10 " 3 2 53 9 10 " 3 2 53 9 10	" 110 14 39 131 " 110 14 39 131 " 110 14 39 131	° 53 ' 53 " 53	1.58963 1.58963 1.58963	0.2008271 0.2009477 0.1992359	9.6588876 9.6587067 9.6622744		D	Zach
			10	" 23 55 39 " 1 17 27 27 s 1 17 27 27	" 3 2 53 9 10 " 3 2 53 9 10 " 3 2 53 9 10	" 110 14 39 131 " 110 14 39 131 " 110 14 39 131	° 53 ' 53 " 53	1.58963 1.58963 1.58963	0.1992359 0.2033933 9.8932745	0.98271088 0.6650383 0.1202165		D	Nicolai
			12	" 18 28 12 " 1 18 42 26 s 1 18 42 26	" 3 2 53 9 10 " 3 2 53 9 10 " 3 2 53 9 10	" 110 14 39 131 " 110 14 39 131 " 110 14 39 131	° 53 ' 53 " 53	1.58963 1.58963 1.58963	0.2033933 9.8932745 9.8966909	0.6650383 0.1202165 0.1150919		D	Oriani
114	115	1812	Sep. 14	h 14 17 16 " 3 2 40 29 s 3 2 40 29	s 8 13 36 25 " 8 13 43 25 " 8 13 43 25	s 6 19 4 474 " 6 18 11 20 73 " 6 19 35 48 74	° 31 30 ' 53 " 53	1.597347 1.588356 0.77835	0.2033933 0.1992359 9.8911749	9.6650383 9.6622744 0.1233660		D	Werner
			14	" 20 35 55 " 3 1 54 45 s 3 1 54 45	" 8 13 36 25 " 8 13 43 25 " 8 13 43 25	" 6 19 4 474 " 6 18 11 20 73 " 6 19 35 48 74	° 31 30 ' 53 " 53	1.597347 1.588356 0.77835	9.8932745 9.8966909 9.8911749	0.1202165 0.1150919 0.1233660		D	idem
			15	" 0 0 0 " 3 2 54 38 s 3 2 54 38	" 8 13 36 25 " 8 13 43 25 " 8 13 43 25	" 6 19 4 474 " 6 18 11 20 73 " 6 19 35 48 74	° 31 30 ' 53 " 53	1.597347 1.588356 0.77835	9.8932745 9.8966909 9.8911749	0.1202165 0.1150919 0.1233660		D	Nicollet
			15	" 15 53 14 " 3 2 39 53 s 3 2 39 53	" 8 13 36 25 " 8 13 43 25 " 8 13 43 25	" 6 19 4 474 " 6 18 11 20 73 " 6 19 35 48 74	° 31 30 ' 53 " 53	1.597347 1.588356 0.77835	9.8932745 9.8966909 9.8911749	0.1202165 0.1150919 0.1233660		D	idem
			15	" 7 40 53 " 3 2 18 44 s 3 2 18 44	" 8 13 36 25 " 8 13 43 25 " 8 13 43 25	" 6 19 4 474 " 6 18 11 20 73 " 6 19 35 48 74	° 31 30 ' 53 " 53	1.597347 1.588356 0.77835	9.8932745 9.8966909 9.8911749	0.1202165 0.1150919 0.1233660		D	Encke
			16	" 6 39 48 " 3 5 3 4 s 3 5 3 4	" 8 13 36 25 " 8 13 43 25 " 8 13 43 25	" 6 19 4 474 " 6 18 11 20 73 " 6 19 35 48 74	° 31 30 ' 53 " 53	1.597347 1.588356 0.77835	9.8932745 9.8966909 9.8911749	0.1202165 0.1150919 0.1233660		D	Oriani
115	116	1813	Mar. 5	h 16 46 0 " 2 6 52 30 s 2 6 52 30	s 2 17 27 30 " 2 17 27 30 " 2 17 27 30	s 0 10 35 0 " 0 10 35 0 " 0 10 35 0	° 27 33 ' 30 " 30	0.67451 0.699197 0.69933	9.8289916 9.8445998 9.8446822	0.2166409 0.1932286 0.1931050		R	Werner
			4	" 12 45 4 " 2 9 57 29 s 2 9 57 29	" 2 17 27 30 " 2 17 27 30 " 2 17 27 30	" 0 10 35 0 " 0 10 35 0 " 0 10 35 0	° 27 33 ' 30 " 30	0.67451 0.699197 0.69933	9.8445998 9.8446822 0.0854348	0.2166409 0.1932286 9.8319765		R	idem
			4	" 12 47 31 " 2 9 56 8 s 2 9 56 8	" 2 17 27 30 " 2 17 27 30 " 2 17 27 30	" 0 10 35 0 " 0 10 35 0 " 0 10 35 0	° 27 33 ' 30 " 30	0.67451 0.699197 0.69933	9.8445998 9.8446822 0.0854348	0.2166409 0.1932286 9.8319765		R	Nicollet
116	117	1813	May 19	h 17 14 47 " 6 17 59 0 s 6 17 59 0	s 1 12 41 49 " 1 12 40 21 " 1 12 40 21	s 6 24 42 49 81 " 6 25 3 15 81 " 6 25 29 480 44	° 23 21 ' 1 " 1	1.21740 1.21532 1.21433	0.0846919 0.0843362 0.0855046	9.830909 9.8336240 9.8318714		R	Daussy
			19	" 12 22 32 " 6 17 37 6 s 6 17 37 6	" 1 12 40 21 " 1 12 40 21 " 1 12 40 21	" 6 24 42 49 81 " 6 25 3 15 81 " 6 25 29 480 44	° 23 21 ' 1 " 1	1.21740 1.21532 1.21433	0.0846919 0.0843362 0.0855046	9.830909 9.8336240 9.8318714		R	idem
			19	" 14 9 34 " 6 17 28 26 s 6 17 28 26	" 1 12 40 21 " 1 12 40 21 " 1 12 40 21	" 6 24 42 49 81 " 6 25 3 15 81 " 6 25 29 480 44	° 23 21 ' 1 " 1	1.21740 1.21532 1.21433	0.0846919 0.0843362 0.0855046	9.830909 9.8336240 9.8318714		R	Werner
			19	" 7 16 54 " 6 17 53 36 s 6 17 53 36	" 1 12 40 21 " 1 12 40 21 " 1 12 40 21	" 6 24 42 49 81 " 6 25 3 15 81 " 6 25 29 480 44	° 23 21 ' 1 " 1	1.21740 1.21532 1.21433	0.0846919 0.0843362 0.0855046	9.830909 9.8336240 9.8318714		R	Nicollet
			19	" 10 27 4 " 6 17 43 46 s 6 17 43 46	" 1 12 40 21 " 1 12 40 21 " 1 12 40 21	" 6 24 42 49 81 " 6 25 3 15 81 " 6 25 29 480 44	° 23 21 ' 1 " 1	1.21740 1.21532 1.21433	0.0846919 0.0843362 0.0855046	9.830909 9.8336240 9.8318714		R	Encke
			19	" 10 14 53 " 6 17 43 8 s 6 17 43 8	" 1 12 40 21 " 1 12 40 21 " 1 12 40 21	" 6 24 42 49 81 " 6 25 3 15 81 " 6 25 29 480 44	° 23 21 ' 1 " 1	1.21740 1.21532 1.21433	0.0846919 0.0843362 0.0855046	9.830909 9.8336240 9.8318714		R	Gerling
117		1815	Apr. 25	h 2 53 5 " 4 27 3 38 s 4 27 3 38	s 2 22 45 21 " 2 22 45 21 " 2 22 45 21	s 2 4 18 17 44 52 " 2 4 18 17 44 52 " 2 4 18 17 44 52	° 43 131 ' 43 " 43	1.23024 1.23024 1.23024	0.092156 0.0899899 9.8251434	9.821894 9.8251434 9.8251434		D	Bessel
			25	" 11 10 54 " 4 27 35 55 s 4 27 35 55	" 2 22 45 21 " 2 22 45 21 " 2 22 45 21	" 2 4 18 17 44 52 " 2 4 18 17 44 52 " 2 4 18 17 44 52	° 43 131 ' 43 " 43	1.23024 1.23024 1.23024	0.0899899 9.8251434 9.8251434	9.8251434 9.8251434 9.8251434		D	Gauss

N.	Delambre	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction	Name of the Computer.
117		1815 Apr. 25	h 3 56 25 23 51 0 25 23 51 0 26 1 9 56 25 23 59 27 25 23 58 5	s 4 27 4 42 4 28 58 48 4 29 2 58 4 29 1 58 4 29 1 56 4 29 3 57 0	s 2 22 47 54 2 23 26 21 2 23 26 50 2 23 28 36 2 23 28 34 2 10 7 0	s 2 4 16 48 2 5 32 27 2 5 36 8 2 5 33 22 2 5 33 22 3 23 50	° 44 52 40 44 30 43 44 30 45 44 29 52 44 29 55 0 89 42	" 1.23717 1.21349 1.213090 1.212941 1.212869 1.19725	0.0924294 0.0840362 0.0838930 0.0838369 0.0838109 0.078185	9.8214812 9.8340840 9.834288 9.8343729 9.8344119 9.842851		D	Encke
118		1818 Feb. 27	6 0 0 6 0 0 26 21 4 17 25 23 10 10	s 6 2 56 52 6 3 22 58 6 2 45 22 6 2 45 22	s 2 10 21 10 2 10 5 2 2 10 26 11 2 10 26 11	s 3 22 35 42 3 23 17 56 3 22 19 11 3 21 46 58	° 48 47 27 0 0 0 0 0 0 0 0 0	" 1.19878 1.20052 1.197764 0.85643	0.0787396 0.07937 0.0783711 9.9326919	9.8420189 9.841073 9.8425716 0.0610949		D	Gauss
119		1818 Dec. 5	0 0 0 0 0 0 4 2 19 23 4 22 35 18 5 0 56 11	s 0 11 28 8 0 11 28 4 0 11 28 13 0 11 28 20 0 11 28 20	s 2 29 55 14 2 29 55 14 2 29 59 53 2 29 59 53 3 0 0 51	s 3 1 46 58 3 1 55 26 3 1 47 31 3 1 47 31 3 1 47 31	° 43 48 30 43 48 30 43 48 30 43 48 30 43 48 30	" 0.85643 0.85643 0.854923 0.854923 0.854923	9.928324 9.9320148 9.9319574 9.9319574 9.54790	0.0676423 0.0621061 0.0621922 0.0621922 0.63828	1.011617	R	Encke
(86)		1819 Jan. 24	21 47 8 24 23 18 56 24 23 8 0 27 2 39 27	s 4 24 23 52 4 26 46 6 4 24 52 12 5 6 14 8	s 10 29 22 47 11 1 21 13 10 29 4 33 11 4 18 8	s 5 25 24 53 5 25 24 53 5 25 47 39 6 1 56 0	° 15 11 43 15 11 43 14 47 42 13 42 30	" 0.32963 0.352563 0.335581 0.335581	9.5472367 9.5237969 9.5237230 9.5330800	0.68310 0.6892732 0.6614329 0.6605083		D	Encke
120		1819 June 27	17 18 46 17 17 42 37 17 19 16 17 18 32 55 17 17 54 51 17 17 20 24 17 11 1 22	s 9 17 13 45 9 17 13 45 9 17 2 38 9 17 24 18 9 17 13 4 9 17 5 54 9 2 34 56	s 9 3 43 57 9 3 43 57 9 3 43 33 9 3 42 52 9 3 42 28 9 3 42 52 3 19 56 47	s 6 2 22 16 6 2 22 16 0 13 29 48 0 13 41 26 0 13 30 36 0 13 23 28 5 12 38	° 38 42 22 38 42 22 45 26 45 26 43 56 44 44 11 53	" 0.342989 0.342989 0.341549 0.3420005 0.341008 0.341051 0.74261	9.5331982 9.53528 9.5340268 9.5327646	0.6603310 0.65721 0.6590881 0.6609814		D	Encke
121		1819 July 20	16 20 0 19 5 26 0 31 3 29 44 18 21 45 39 18 21 11 8	s 9 2 34 56 9 0 9 31 9 20 40 12 9 4 40 51 2 9 52 53	s 3 19 56 47 3 20 3 34 3 24 31 21 3 23 10 46 2 23 34	s 5 12 38 5 10 57 5 26 8 5 11 30 3 11 16	° 11 53 13 11 46 9 11 16 53 10 42 48 11 44	" 0.74261 0.76285 0.70008 0.773638 0.86744	9.87076 9.88244 9.84515 9.8885378	0.15339 0.13647 0.19240 0.1273216	0.60353 0.75519035	D	Encke
122		1819 Nov. 16	21 11 8 21 1 7 48 20 6 2 55	s 2 11 23 44 2 11 23 44 2 7 18 48	s 2 20 57 29 2 17 13 57 2 17 13 57	s 11 20 26 11 20 4 11 20 4	° 56 13 9 56 13 9 56 13 9	" 0.87878 0.892559 0.892559	9.94388 9.9506368 9.9506368	0.04431 0.0341731 0.0341731	0.6867458	D	Encke

N.	Declination	Date.	Passage of the Perihelium in Parisian mean time.	Longitude of the Perihelium.	Longitude of the ascending node.	Angle between the Perihelium and the node.	Inclination.	Distance in the Perihelium.	Log. Dist. Perihelium.	Log. mean motion.	Eccentricity.	Direction	Name of the Computer.	
123		1821	Mar. 21	h 12 31 48 s 7 29 28 21 " 7 29 40 27 " 7 29 35 53 " 7 29 34 5 " 7 29 18 37 " 7 29 34 7 " 7 23 8 " 7 29 30 33 " 7 29 29 25	S 1 18 38 48 " 1 18 46 30 " 1 18 44 18 " 1 18 43 34 " 1 18 32 12 " 1 18 44 15 " 1 19 38 17 " 1 18 42 18 " 1 18 40 56	S 5 19 10 27 " 5 19 6 37 " 5 19 8 25 " 5 19 9 29 " 5 19 13 35 " 5 19 10 8 " 5 19 8 9 " 5 19 11 45 " 5 19 11 31	° 73 39 40 ' 73 8 53 " 73 20 0 " 73 23 15 " 73 10 55 " 73 19 44 " 73 32 41 " 73 34 53 " 73 33 7	0.091808 0.0927082 0.0922882 0.092185 0.091113 0.092172 0.089401 0.091677 0.091822	8.96288 8.967118 8.9651463 8.96466 8.95958 8.9645990 8.95134 8.9622604 8.9629523	1.51581 1.509451 1.5124088 1.51314 1.52076 1.5132298 1.53312 1.5167377 1.5156992	R R R R R R R R R	R R R R R R R R R	Encke Bessel Rümker Nicolai Nicollet v. Staudt Brinkley idem Rosenberger	
124		1822	May 5	6 12 44 9 7 49 9 5 51 13 5 15 51 5 12 45 31 5 6 32 13 5 14 3 30	S 5 26 26 9 " 5 26 35 58 " 5 26 38 54 " 5 27 30 50 " 5 27 22 26 " 5 26 38 4 " 5 27 27 22	S 11 13 42 0 " 14 52 42 53 " 13 56 24 53 " 14 42 53 34 " 14 36 52 53 " 13 34 44 53 " 14 41 34 53	° 53 41 0 ' 53 36 7 " 53 33 0 " 53 34 3 " 53 36 12 " 53 48 36 " 53 34 48	0.509472 0.512106 0.504551 0.504220 0.504309 0.502736 0.504429	9.70712 9.70936 9.702905 9.70262 9.7026967 9.70134 9.70280	0.40695 0.39609 0.4057708 0.406198 0.4060833 0.408118 0.405928	R R R R R R R	R R R R R R R	R R R R R R R	Carlini Ursinus Hansen Nicollet Gambart Encke idem
(86)		1822	May 23	23 51 52 5 7 11 29	4 19 32 11 4 19 32	6 2 51 57 6 2 51 57	° 13 22 25 " 13 22 25	0.345793	9.5388157	0.6519047	0.8445479	D	Encke	
125		1822	Oct. 23	6 5 29 8 18 14 23 13 46 40 23 15 22 43 23 15 15 48 23 7 20 26 23 13 20 48 23 15 11 19 24 23 17 24 23 23 4	S 3 2 28 2 " 3 2 25 7 " 3 2 33 4 " 3 2 43 58 " 3 2 43 47 " 3 2 26 2 " 3 2 38 18 " 3 2 42 32 " 3 3 5 3 " 3 2 47 31	S 6 0 8 22 " 6 0 14 12 " 5 29 21 37 " 6 0 56 65 " 6 0 55 38 " 6 0 18 05 " 6 0 41 46 " 6 0 54 20 " 6 2 83 22 " 6 1 17 35	° 52 32 52 ' 52 30 55 " 52 36 22 " 52 39 48 " 52 39 61 " 52 30 15 " 52 36 52 " 52 39 11 " 52 39 42 " 52 39 7	1.152975 1.151830 1.148694 1.14612 1.146357 1.151870 1.147602 1.146401 1.133710 1.1433992	0.06182 0.061390 0.0602033 0.05923 0.05932 0.0614036 0.0597898 0.0593864 0.0545019 0.0581979	9.867398 9.868043 9.8698233 9.871283 9.871148 9.8680229 9.8704436 9.8711237 9.8783754 9.8728314	R R R R R R R R R R	R R R R R R R R R R	R R R R R R R R R R	Schnürlein Argelander Gambart Nicolai idem Hansen idem idem Encke idem

iii. *Copy of a Report to the Board of Customs, containing a description of an improved SLIDING RULE for GAUGING Casks.*

Sir,

IN the Report which I addressed to you a few months since, stating my opinion of Mr. Watts's proposals for the improvement of gauging, I promised to send some further observations for the consideration of the Board of Customs, as soon as the legislature should have come to a decision respecting the alterations which have been proposed in the system of weights and measures; and though it seems that the wine gallon must remain for the present in use, yet as there is every reason to imagine that an imperial gallon, exactly one fifth larger, will ultimately be adopted, it might be right to suspend the introduction of any new instruments into general use, until the proposed regulations shall have been more fully appreciated by the House of Lords, and to ascertain in the mean time how far the instrument, which I have the honour to present to the Board, is likely to fulfil the purposes for which I have constructed it, that is, for determining, upon principles which are entirely new, and with the greatest possible simplicity and expedition, the approximate content of any cask whatever, subject to any further corrections which either theory or experience may dictate in particular cases.

My sliding rule contains four graduated lines, marked, BUNG DIAMETER IN INCHES AND TENTHS, HEAD DIAMETER, LENGTH, and CONTENT IN GALLONS.

The computation is performed by merely bringing the head diameter of the given cask to the bung, on the respective lines; the content may then be read off opposite to the length of the cask.

The degree of accuracy of the result may be inferred from the contents of twenty-one casks, as very carefully determined by Mr. Watts, at my suggestion, and by order of the Board.

No.	Bung	Head	Length	(Wake)	Content by weight	Sliding Rule	Error
I.	30.0	21.8	46.8	1.3	115.3	116.3	+ 1.0
II.	28.6	21.7	47.0	1.4	108.0	109.4	+ 1.4
III.	31.7	22.9	50.1	1.7	141.2	138.3	- 2.9

No.	Bung	Head	Length	(Wake)	Content by weight	Sliding Rule	Error
IV.	31.4	26.6	46.4	0.4	137.4	139.4	+ 2.0
V.	32.6	24.5	44.2	1.4	131.7	132.3	+ 0.6
VI.	32.3	24.4	48.5	0.4	142.5	143.2	+ 0.7
VII.	29.4	25.3	45.8	0.3	122.4	121.9	- 0.5
VIII.	32.7	26.3	42.4	1.1	133.5	133.6	+ 0.1
IX.	28.6	22.4	48.5	1.0	114.7	115.0	+ 0.3
X.	32.4	26.8	35.9	0.9	112.8	113.1	+ 0.3
XI.	39.8	33.0	51.9	1.0	248.0	247.2	- 0.8
1	30.6	26.1	45.8	0.4	130.8	131.4	+ 0.6
2	30.9	26.0	47.2	0.2	136.8	136.6	+ 0.2
3	29.1	23.1	48.8	0.2	120.9	120.8	- 0.1
4	31.2	26.4	45.4	0.3	134.7	134.4	- 0.3
5	32.7	26.0	43.1	0.6	133.8	134.7	+ 0.9
6	32.3	27.9	34.6	0.4	110.0	111.4	+ 1.4
7	32.1	27.5	35.3	0.3	110.0	111.6	+ 1.6
8	29.5	21.7	47.1	1.5	116.0	114.1	- 1.9
9	31.5	23.2	50.1	2.1	140.7	138.2	- 2.5
10	29.7	25.3	47.3	0.2	125.8	128.0	+ 2.2

It appears from this table that the error of the sliding rule is less than a gallon in twelve out of the twenty-one pipes, and that it never amounts to three gallons, including the effect of whatever accidental irregularities there may have been in the form of the staves. The whole sum of the errors, for the twenty-one pipes, amounts to twenty-two gallons : the errors of the common mode of computing amount to twenty-six, with all the allowances made by the most experienced gaugers : so that by one simple operation, the new sliding rule gives at once a result at least as correct, as the best methods now in use by two or three ; and this result remains susceptible of correction, by any further computations that may be thought necessary.

It may be proper, if great accuracy in the result be required, and be thought attainable, that a table of corrections should hereafter be computed which would be entered with the difference of the bung and head diameters, and also with the "wake," that is, as I have already applied the term in a former communication, the

fall of the bung below a line touching the staves at the head. The rule itself gives a perfectly correct result in casks that differ but little from a cylinder; and it may be observed in the III^d and IVth examples, that a great wake appears to require some little addition to be made to the content, and a small wake some subtraction: and the casks 8 and 9, compared with 10, will also serve to indicate the propriety of a similar correction. I shall explain, in a separate note, the principles on which such a computation may be made, if required; but I am not confident, from the result of all the cases I have examined, that the advantage of these minute corrections would not be perfectly inconsiderable, in comparison with the unavoidable irregularities of the forms of the casks, and the probable errors in their admeasurement; especially as in any large number of casks that are to be gauged at the same time, the errors of the different casks being most commonly divided between the opposite sides of the truth, would have a general tendency to neutralise each other.

On the whole, therefore, I have reason to believe that the new sliding rule alone will be found quite as accurate as can be required for the ordinary purposes of the revenue, and that the simplicity of its operation will be found to save much time and labour, and to avoid all chance of error in computation; and I trust that the Board of Customs will be pleased to order some of its officers to make trial of it in their practice on a large scale.

I have the honour to be,

Sir,

Your obedient humble servant,

P. Delavaud, Esq.,

THOMAS YOUNG.

&c. &c. &c.

NOTE on the new Sliding Rule.

The formula represented by the sliding rule is this, $\frac{203}{150} \text{ Log.}$

$$B + \frac{97}{150} \text{ Log. } H + \text{Log. } L - \text{Log. } \left\{ \frac{294 \text{ W.G}}{353 \text{ I.G}} \right\} = \text{Log. Content:}$$

or otherwise $B^{1.3533} \times H^{.6467} \times L : 294 = \text{Content.}$ The

different lines are therefore laid down from three different logarithmic scales, such that the distance from 1 to 2 on the line B is to the distance from 1 to 2 on the lines L and C, as $\frac{203}{350}$ to 1, the similar distance on the line H being only $\frac{97}{150}$ as great; the sum of these distances on the lines B and H amounting to $\frac{300}{150}$; so that if B and H were equal, this sum would represent their square, as it obviously ought to do, while in other cases it would approach very near to the square of a mean diameter equal to $H + \frac{2}{3}(B - H)$.

The same result might also be obtained from a table constructed according to this formula as from the rule, adding together the logarithm of B, H, and L, that of 294 being previously subtracted throughout from the numbers of one of the former columns, so that the third might serve both for L and for C.

Table for graduating the Sliding Rule.

Inches	I. B.	II. H.	III. L. IV. C.	Inches	I. B.	II. H.	III. L. IV. C.
10.0		0.000		22.0	13.830	16.359	3.057
.5		1.012		.5	14.806	16.825	3.779
11.0		1.978		23.0	15.761	17.281	4.484
.5		2.900		.5	16.695	17.728	5.199
12.0		3.783		24.0	17.609	18.165	5.850
.5		4.625		.5	18.505	18.093	6.536
13.0		5.443		25.0	19.382	19.011	7.159
.5		6.225		.5	20.242	19.420	7.794
14.0		6.980		26.0	21.085	19.825	8.417
.5		7.709		.5	21.913	20.221	9.029
15.0		8.412		27.0	22.724	20.608	9.627
.5		9.092		.5	23.521	20.990	10.192
16.0	0.000	9.752		28.0	24.304	21.363	10.795
.5	1.336	10.390		.5	25.072	21.730	11.362
17.0	2.633	11.008		29.0	25.828	22.086	11.922
.5	3.892	11.611		.5	26.570	22.445	12.469
18.0	5.115	12.193		30.0	27.300	22.794	13.008
.5	6.305	12.764		.5	28.018	23.138	13.539
19.0	7.463	13.316		31.0	28.724	23.475	14.060
.5	8.591	13.856		.5	29.419	23.806	14.574
20.0	9.691	14.381	0.000	32.0	30.103	24.133	15.079
.5	10.763	14.897	0.791	.5	30.776	24.455	15.576
21.0	11.810	15.394	1.565	33.0	31.439	24.772	16.066
.5	12.832	15.886	2.320	.5	32.092	25.083	16.548

Inches	I. B.	II. H.	III. L. IV. C.	Inches	I. B.	II. H.	III. L. IV. C.
34.0	32.736	25.392	17.027	57.0			33.601
.5	33.370	25.694	17.517	.5			33.882
35.0	33.995	25.993	17.929	58.0			34.159
.5	34.611	26.286	18.412	.5			34.435
36.0	35.218	26.577	18.853	59.0			34.708
.5	35.817	26.863	19.300	.5			34.979
37.0	36.408	27.145	19.736	60.0			35.247
.5	36.991	27.424	20.167	.5			35.514
38.0	37.566	27.699	20.592	61.0			35.775
.5	38.134	27.970	21.012	.5			36.040
39.0	38.694	28.238	21.426	62.0			36.299
.5	39.248	28.502	21.835	.5			36.557
40.0	39.794	28.763	22.236	63.0			36.812
.5	40.334	29.021	22.637	.5			37.065
41.0	40.866	29.275	23.029	64.0			37.318
.5	41.393	29.527	23.420	.5			37.567
42.0	41.913	29.776	23.806	65.0			37.815
.5	42.427	30.021	24.183	.5			38.061
43.0	42.935	30.264	24.559	66.0			38.329
.5	43.437	30.504	24.932	.5			38.547
44.0	43.933	30.741	25.296	67.0			38.789
.5	44.424	30.975	25.658	.5			39.026
45.0	44.909	31.207	26.017	68.0			39.263
.5			26.371	.5			39.498
46.0			26.722	69.0			39.731
.5			27.069	.5			39.960
47.0			27.412	70.0			40.193
.5			27.707	.5			40.421
48.0			28.083	71.0			40.648
.5			28.420	.5			40.873
49.0			28.750	72.0			41.096
.5			29.075	.5			41.319
50.0			29.398	73.0			41.539
.5			29.717	.5			41.758
51.0			30.033	74.0			41.975
.5			30.346	.5			42.192
52.0			30.655	75.0			42.406
.5			30.963	.5			42.619
53.0			31.267	76.0			42.831
.5			31.568	.5			43.066
54.0			31.869	77.0			43.251
.5			32.162	.5			43.458
55.0			32.455	78.0			43.689
.5			32.746	.5			43.870
56.0			33.034	79.0			44.073
.5			33.319	.5			44.276
				80.0			44.477

The first three lines may begin from any given points; the fourth must be so placed that when B 28 and H 28 are brought together, L 30 may stand exactly against C 80.

Mode of computing the content of a Cask from the WAKE.

The *wake* is the drop of the bung below the cone touching the cask at the head, or half the difference between the bung diameter and that of the base of a cone in which the half cask is inscribed, so as to touch it exactly at the head. This element may be measured without much difficulty by means of a straight rod, with two fixed nails, of equal length, projecting from it near one end, and a third nail sliding along it, so as to stand over the bung when the former two are pressed down upon the stave between the hoops at the head, while the distance of its point from the bung is measured by a scale, or by a pair of compasses.

The direction of the surface of the staves being given in three given points through which it passes, we shall only have to assume that the curvature varies in a uniform manner, from its greatest magnitude at the bung, to its least magnitude at the head, in order to obtain a form which must very nearly coincide with the whole outline of the staves. The most convenient supposition respecting the curve is that it is of the nature of a parabola, either of an order inferior to the common parabola, and beginning at the bung, or of a higher order, beginning at the head, and meeting its companion at the bung in a direction parallel to the axis; and the latter form will be found, on examination, to be the most applicable to practical cases, the former approaching too much to a cone.

Now in all parabolas, when the ordinate is ax^n , the distance of the tangent from the curve, on the axis, or, in other words, the wake of the cask, is $(n - 1) ax^n$; since the fluxion of the ordinate is $nax^{n-1} dx$, and, as dx is to this, so is the absciss x to nax^n , the sum of the ordinate, and of the distance in question; and making this distance $= k$, the ordinate being here $\frac{b-h}{2}$ we have $ax^n = \frac{b-h}{2}$:

while $(n - 1) ax^n = k$; consequently $n - 1 = \frac{2k}{b-h}$; or, if $b - h$

$= d, n - 1 = \frac{2k}{d}$, and $n = 1 + \frac{2k}{d} = \frac{d + 2k}{d}$. On the other hand, for a parabola having its vertex at the head, the wake becomes the ordinate, and $\frac{d}{2}$ assumes its place, so that n , or rather m , will be $1 + \frac{d}{2k} = \frac{d + 2k}{2k}$.

For the inferior parabola, the diameter of the cask, at the distance x from the middle, is always $b - ax^n$; its square $b^2 - 2abx^n + a^2x^{2n}$, and the content, considering the section as a square, $bx - \frac{2}{n+1} abx^{n+1} + \frac{1}{2n+1} a^2x^{2n+1}$; but when $x = \frac{l}{2}$, $ax^n = a \left(\frac{l}{2}\right)^n = d$, and we have, for the whole content, $2 \left(b^2 \frac{l}{2} - \frac{2}{n+1} bd \frac{l}{2} + \frac{1}{2n+1} d \frac{l}{2} \right) = l \left(b^2 - \frac{2}{n+1} bd + \frac{1}{2n+1} d^2 \right) = l \left(b^2 - \frac{d}{d+k} bd + \frac{d}{4k+3} d^2 \right)$.

For the superior parabola, the diameter, at the distance x from the head, is $h + cx - ex^m$; c being such, that $c \frac{l}{2}$ may be equal to $d + 2k$, and $e \left(\frac{l}{2}\right)^m$ being $= 2k$. Then the square of the diameter will be $h^2 + 2chx + c^2x^2 - 2ehx^m - 2cex^{m+1} + e^2x^{2m}$, and the content $h^2x + chx^2 + \frac{1}{3} c^2x^3 - \frac{2}{m+1} ehx^{m+1} - \frac{2}{m+2} cex^{m+2} + \frac{1}{2m+1} e^2x^{2m+1}$; which, for the whole length, becomes $l \left(h^2 + \frac{1}{2} chl + \frac{1}{12} c^2l^2 - \frac{2}{m+1} eh \left(\frac{l}{2}\right)^m - \frac{2}{m+2} ce \left(\frac{l}{2}\right)^{m+1} + \frac{1}{2m+1} e^2 \left(\frac{l}{2}\right)^{2m} \right) = l \left(h^2 + (d + 2k) h + \frac{1}{3} (d + 2k)^2 - \frac{4}{m+1} hk - \frac{4}{m+2} (d + 2k) k + \frac{4}{2m+1} k^2 \right) =$

$$l(h^2 + (d + 2k)h + \frac{1}{3}(d + 2k)^2 + \frac{4k}{d + 3k}k^2 - \frac{8k}{d + 4k}hk - \frac{8k}{d + 6k}(d + 2k)k).$$

iv. *Remarks on Professor Struve's Observations to determine the Parallax of the fixed Stars. By J. Pond, Esq., Astr. Royal.*

OF the various attempts to discover the parallax of the fixed stars, the observations of Professor Struve must be regarded as among the best and most judicious. [*Obs.* Vol. II. III.]

His object is, by means of an excellent transit instrument furnished with seven wires, to determine the sum of the parallaxes of several fixed stars, differing nearly 12 hours in right ascension from each other.

The results which he obtains seem to verify a remark which I have often had occasion to make; that in proportion as any improvement takes place either in our instruments or our processes the resulting parallax becomes proportionally less.

Of fourteen sets of opposite stars thus compared, Mr. Struve finds seven, which give the parallax *negative*; this circumstance alone should suggest great caution in attributing to the effects of parallax the small positive quantities that are derived from the remaining seven. Mr. Struve however is inclined to assign 0".16 of space as the parallax of δ Ursæ Minoris, and 0".45 for the sum of the parallaxes of α Cygni, and γ Ursæ Majoris. His learned coadjutor, M. Walbeck, who, it appears, has undertaken the calculations, is disposed to attribute the greatest portion of this parallax to the smaller star; a circumstance so improbable requires very strong evidence for its support.

But whatever reasonable doubt we may entertain as to * any one given result relating to such extremely minute quantities, yet the mean of the whole must be admitted to deserve very great confidence; and it is to this view of the subject (omitted by the learned author,) that I wish to direct the attention of Astronomers.

* It should be remembered, that in a series of observations, it generally happens that some results will be erroneous by a greater quantity than the mean probable error.

If we take the mean of the fourteen results as relating generally to stars from the 1st to the 4th magnitude, it will appear that the mean sum of the parallaxes of two opposite stars is equal to $0''.036$ of space, or the parallax of a single star equal to $0''.018$.

If any reliance can be placed on these observations, every attempt to determine the parallax of these stars in declination must be entirely hopeless; since in this case we can only measure the shorter axis of the Ellipse, and the uncertainty of refraction must amount, at least, to twenty times the quantity we are in search of.

v. *An account of some Parhelia seen at the Cape of Good Hope.*

By the Rev. Fearon Fallows, A.M.

June 21, 1823,

My dear Sir,

Cape Town.

If you think the following worthy of insertion in any Scientific Journal, it is at the Editor's service.

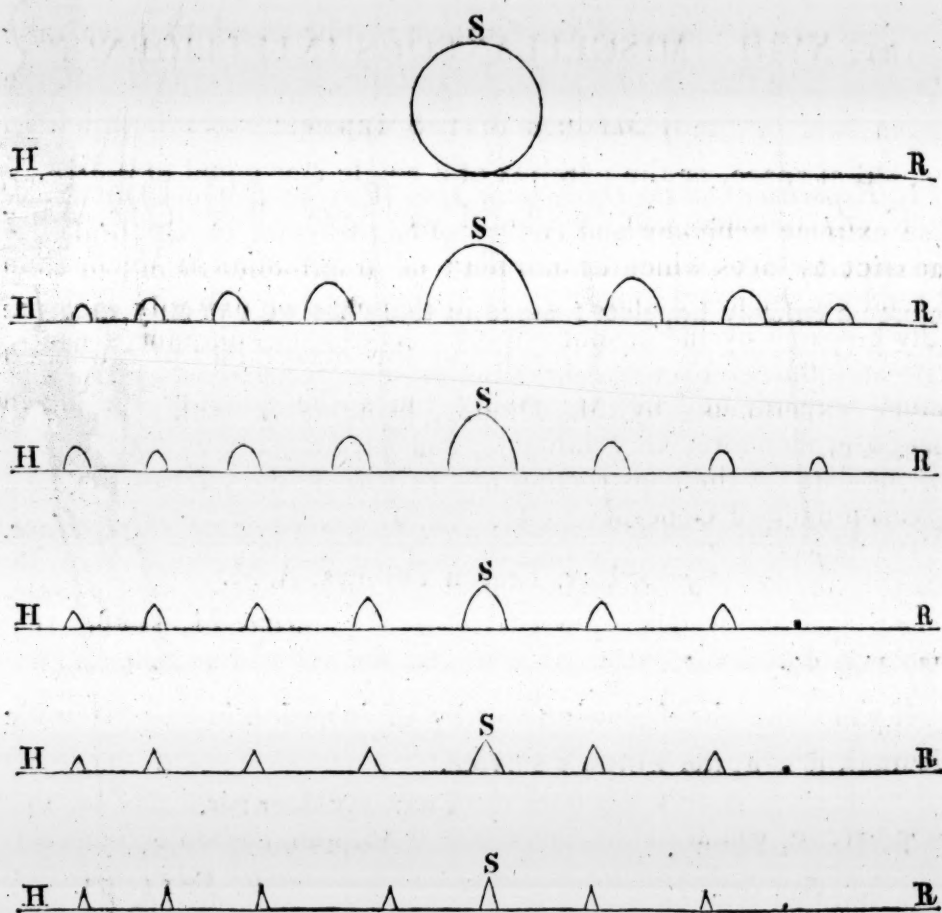
I am, my dear Sir,

To Dr. T. Young,
&c. &c. &c.

Yours most truly,
F. FALLOWS.

Wednesday Evening, May 7, 1823.—During my ride this evening toward Sea-point, I was favoured with a most beautiful sight at sunset. The sky was delightfully clear;—not a cloud was visible, and the sea horizon remarkably distinct. When the sun's lower limb had just dipped the water-edge, immediately several parhelia made their appearance,—four on the left hand, and three on the right. They assumed the same shape as the real sun, and were as bright, but not so large. When the upper limb of the sun came in contact with the horizon, it, and the mock suns, appeared as bright points upon the water edge, and then, in an instant, all vanished together. Upon my return home, I made a diagram of this phenomenon, as seen at short intervals after each other, a copy of which (in preference to a minute description,) I beg here to subjoin.

H R the horizon, S the real sun. The remaining figures upon H R are the mock suns. Bar. 30.2 inches. Ther. 64 inches.



The morning of the 8th of May was cloudy, and indicated rain, quite contrary to what might have been expected from the clearness of the preceding evening.

N. B. On the *evening of the 8th*, we had a great deal of *thunder and lightning*.

Note by DR. YOUNG. There is every reason to suppose that these parhelia must in reality have been only fragments of coronæ, formed by the diffraction of a cloud rising but little above the horizon: the absence of colours may easily have depended on the absorption of all the light, except the red, in its long passage through a hazy atmosphere. I have seen a rainbow at sunrise, or rather a little before sunrise, in which no other colour whatever but red was perceptible.

vi. *Error in TAYLOR'S LOGARITHMS.*

Cosine of $37^{\circ} 29' 2''$, for 5503, read 5603. H. J.

ART. XVIII.—MISCELLANEOUS INTELLIGENCE.

I. MECHANICAL SCIENCE.

1. *Experiment on the tenacity of Iron Wire, by Colonel Dufour.*—The extreme economy and facility of construction of wire bridges* are circumstances which cannot but tend to introduce them into very general use: hence a knowledge of the strength of iron wire as generally prepared by the manufacturers, and the circumstances which have an influence over it, cannot but possess great interest. The following experiments by M. Dufour, being made with a practical view, are, therefore, very valuable, and have already assisted in furnishing data for the construction of two wire bridges across the fortification ditch of Geneva.

The object of the experiments were to determine the absolute strength of wires of different diameters; their elongation when sustaining a given weight; the effects of a sudden concussion; the influence of annealing at a red heat, and the effect of a fold, or return, or junction of the wire, in determining rupture when in these circumstances.

Four kinds of iron wire were chosen, having the respective diameters of 1, 2, 3, and 4 millimetres nearly. Six experiments on the finest wire, of which the diameter was 0.85, mm. (0.033 of an inch,) proved that the strength was independent of the length; that the mean absolute force of such a wire was 106lbs. avoirdupois, the extremes being 103.7 and 120; and that when annealed, it sustained only 46.3lbs. Ten experiments on the second wire diameter 1.9 mm. or 0.748 of an inch gave 432.5lbs as the mean weight it could sustain, the extremes being 397 and 457; from which it would appear that the first wire had a seventh more of strength in proportion to its diameter than the second. The second wire, when annealed, sustained only 223lbs., which is to its strength when unannealed, as 100 to 194. The third wire about .118 of an inch in diameter, sustained as the mean of six experiments 843lbs.: when annealed its strength was to that of the unannealed wire, as 100 to 195. The fourth wire, of a diameter of .145 of an inch, supported 1713lbs. when unannealed, and 889lbs. when annealed, the ratio in the two states being as 100 to 192.

From these experiments Colonel Dufour concludes that iron wires from 1 to 4 millimetres in diameter, support at least 132lbs. for each square millimetre of their section. But according to known experiments on forged bars of iron, it has been ascertained, that those which are not more than 6 mm. square, do not support more than from 88 to 100lbs. per square millimetre, and those which are larger only from 55 to 66lbs., a circumstance which sufficiently proves the

* See Vol. XV. pp. 136—373 of this Journal.

advantage of employing iron drawn into wires, rather than forged into bars, when the question relates to its tenacity.

The second object of the experiments was to ascertain the elongation of a wire when submitted to a weight, less than that sufficient to break it. The elongation due to the mere rectification of the sinuosities and curves in the wire itself, was found to be $\frac{45}{1000}$ of the original length, when a bundle of twelve wires of the second kind before referred to and 30 feet long, was charged with a weight of 6621lbs. Another kind of elongation immediately precedes the rupture, and is due to a slight diminution of diameter. It may be perceived when the wire is charged with two-thirds of the weight, it is capable of supporting; and varies between 35 and 57 ten-thousandths of the length. When the wire is annealed the elongation is very considerable, and about thirteen-hundredths of the total length in all the wires tried.

The influence of folds, returns, &c., on the tenacity of the wire was of great importance considering the object of the experiments: the following are some of the practical results obtained. When a wire is passed round a ring or cylinder, so as to return parallel to itself, and bear a force applied to the two extremities nearly double that supported by the single wire, it requires that the diameter of the cylinder round which it passes should be at least $1\frac{1}{2}$ inches. In proportion as the diameter is smaller, or the curvature of the wire greater, its tenacity diminishes, and the wire will constantly break at that place. One or more entire revolutions of the wire on the same cylinder must be avoided, because the friction resulting from such an arrangement, opposes the equality of stress which is required upon each of the several wires constituting a bundle.

After many experiments on the different means of joining wires together, experience pointed out as the most efficient, one which would perhaps not have been indicated by theory. The method was to lay the ends side by side one over the other, and bind them round for the space of at least $1\frac{3}{4}$ of an inch, by a smaller annealed iron wire. Such a junction always resisted the proofs applied, the wires constantly giving way at some other place.

The preceding experiments were made with weights gradually accumulating, and unaccompanied by any sudden impulse or momentum, but as in their application to the construction of bridges, effects of the latter kind, would be continually occurring, further experiments were made of this nature. The wires were therefore charged with about half the entire weight they were able to support, and then other weights dropped from different heights into the box containing the previous charge. The latter force was always estimated by its momentum, and experiment proved that the second wire, for instance, charged with half the weight it was just able to bear, could sustain without risk a quantity of momentum equivalent to 3000, the weight being given in killograms (2.207lbs.) and the velocity by the centimetres traversed in a second.

Other experiments were made with reference to the effect of temperature on the tenacity of the wire, but for results of this kind, we refer our readers to p. 373, vol. xv., of this Journal: the results there stated are the same as those quoted with the above.—*Bib. Univ.* xxiii. 305.

2. *Suspension Bridge of Iron Wire at Geneva.*—The preceding researches have been applied with the greatest success, in the construction of two bridges across the dry ditches of the fortifications of Geneva. The first of these ditches is 33 feet deep and 108 feet wide at the site of the bridge; the second is 22 feet deep and 77 feet wide; they are separated by what is called the countergard, which is about 70 feet wide, and the top of which is level with the surrounding soil. A stone building is erected on the city edge of the first ditch, which serves as a point of attachment for the wires, as a gate to the city, and also as a station for the persons who have charge of the bridge; a piece of masonry is erected on the countergard, as a point of support for both bridges; and a third erection of a similar kind, serves as an outer gate, and for a support to the end of the outer bridge. The wire used is of the kind called No. 14 in commerce, very nearly of the diameter of the second sort referred to in the preceding experiments; it is made up into lengths or bundles, each containing 100 wires, and there are three such collections on each side of the bridge. As the line of suspension proceeds uninterruptedly across both ditches and the intervening bank, the length was found too great for one bundle; they were therefore made in shorter lengths, terminating at each end with a ring, and were connected by placing these rings side by side, and passing a strong iron bolt through them. Each single wire was first stretched by a weight of 220lbs., then made up into the bundles of 100 each, which were united by iron ties at successive intervals, and the whole rolled round with iron wire, which gives to them the appearance of cords. The longest of these bundles are 120 feet each, the others were made shorter, as being more convenient for the situation they would occupy in the line of suspension. From this arrangement it is evident that each of the six main lines of suspension may be considered as one bundle, though consisting of many parts; they are made fast at one extremity to a plate of iron firmly attached to the stone gate before mentioned, then pass over the first ditch, across the stone support on the countergard, over the second ditch, over the second standard, and are finally made fast to iron bars, which being attached to plates, are loaded with masses of stone and buried in the earth.

From the six principal lines other lines descend consisting each of twelve wires only; these are made fast to the traverses, or pieces of wood which form the bases of the bridges. On these are mortised long pieces of carpentry, which are bolted together with them, and to which are fastened the railings of the bridges, and then other planks are fastened across these again, forming the path of the bridge.

The rapid and complete success of this undertaking, does great

honour to M. Dufour. It was not quite finished at the time when M. Pictet wrote his account of it, but would be completed in a few days more. It had been planned and executed in the short space of six months. Its expense was previously estimated at 16,000 francs, and the cost amounted to within one or two hundred francs of that sum. This accuracy of estimation is not the least merit of M. Dufour, the engineer. The expectations with regard to the duration of the bridges are all in their favour; the iron is defended from rust by a thick coat of paint, which is to be renewed when required; the wood-work is of select materials, and not being any where in contact with the earth is not liable to rot.

Before constructing the large bridges, a model was made 38 feet long, and having only two suspending lines each composed of 12 wires of .073 of an inch in diameter. The foot-way was constructed on 11 wooden traverses, which hung from the suspension lines each by only four single wires, two at each end. This bridge was submitted to the roughest trials on the part of those persons who were curious to examine it, such as leaping, marching, &c., but without the least accident or failure.—*Bib. Univ.* xxiii. 305.

3. *Hydraulic Experiments on the Propagation of Waves*, by M. Bidone of Turin.—The following is the translation of an extract made by M. Hachette, and inserted in the proceedings of the Philomatic Society. M. Bidone proposed to compare the results of experiments on the propagation of waves, with those deduced from the theory published by M. Poisson, in the *Mémoires of the Academy* 1816. This theory supposed that the waves were produced by a solid segment of a given figure slightly immersed in the fluid, and which after having allowed time for the fluid to assume a state of repose, is suddenly withdrawn in a vertical direction.

M. Bidone observes, that the body rapidly withdrawn, is followed by a column of water which rises above the level, and produces on descending, waves which are propagated in the same time with the primitive waves. Two causes concur in this elevation of the column of water, the pressure of the atmosphere, and the adhesion of the fluid particles to each other and to the body immersed. The height, the volume, and form of the column, depend on the figure of the segment immersed, and principally on the rapidity with which it is withdrawn. M. Bidone mentions many examples of raised columns of water, obtained by plunging successively a cone, a paraboloid of revolution, a cylinder and hemispheres, but his principal object being to produce undulations due to the cavity of the plunged segment, and the mere action of gravity, and to approach as nearly as possible to the hypothesis of M. Poisson, he has observed the primitive waves propagated at the surface of the liquid, at the instant when the removal of the body from the water commenced. The time which intervenes before the adhering column of water begins to fall, is more or less according to the height and figure of the column. When the

immersed body is not withdrawn rapidly, but slowly, the waves are not produced, but at the instant when the body is detached from the water.

The duration of the experiments on the primitive waves varied from one to six seconds; and the results were found by M. Bidone to accord with the theory of M. Poisson, when such experiments could be made, as satisfied the conditions serving as a foundation for the theory. M. Bidone terminates his memoir by remarks on the figure of waves obtained by striking the surface of water with prismatic segments, having triangular, square, and elliptical bases; they present phenomena similar to those exhibited by apertures, with their edges of the same forms. On comparing, for example, the square base of the prismatic segment to the wave formed by this segment, it was seen that the wave had the form of a quadrangle with rounded angles, and that the summits of the angles of the square base corresponded to the middle of the sides of the quadrangle.

The first part of the memoir of M. Bidone contains a verification of a formula, given by M. Eytelwein of Berlin, for calculating the velocity of water in a rectilinear canal; the section of the current and its perimeter, and the inclination of the canal taken at the upper surface of the water, or at the bottom of the canal parallel to that surface, being known. The accordance between the velocities observed and calculated according to the formula is remarkable. The difference is at most, only a forty-eighth of the first quantity.

4. *On a Phenomena of Shadows*, by M. Mongez.—When the sun is free from clouds, the shadow of bodies is surrounded by a penumbra, very sensible, though much more obscure than the shadow; when two bodies, each producing a shadow, are made to approach each other, at the moment preceding the contact the shadows advance towards each other, and change their form at the point of contact; the shadow of a right line thus becomes a curve, and that of a globe like the summit of a paraboloid. M. Arago attributes the effect to the superposition of the penumbras accompanying the bodies; thus if the intensity of the penumbras was only half that of the shadow, it would be doubled at the instant when the two were superposed, and thus produce an obscure part of equal depth with the shadow, which being added to it, would alter its form in that place.—*Bib. Univ.* xxiii. 323.

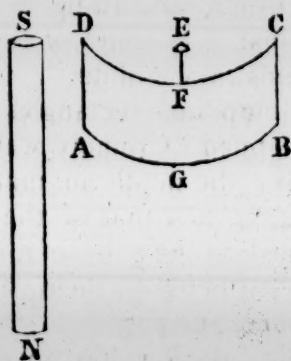
5. *On the Vibration of Air*.—M. F. Savart has published a variety of experimental researches into the nature of the vibrations performed by air, both in tubes and also in spaces of irregular form, but bounded by solid bodies; the latter are entirely new, and, with the former, possess great interest to those who delight in this branch of science. We cannot give a better idea of the nature of these results than by

quoting the conclusion of the memoir of M. Savart. The memoir itself is long, and will probably engage our attention again at a future time, in the progress of foreign science.

"It results from these researches that masses of air, limited at every point of their extent, or even only at part of their extent, can enter into a state of vibration by communication, like those which are contained in tubes; and that when one is in an apartment where a sound is produced, one is, as it were, in a large organ-pipe, where the sonorous vibrations encountering each other, without doubt, in various directions, form centres of vibration and nodal surfaces, of which the form and direction vary almost infinitely, according to the form of the place where the phenomenon occurs, and according to its extent and the position of the different bodies which the vibrations may meet with, and which by themselves may, either by acting as vibrating bodies or not, influence the position of the vibrating parts and the intensity of the motion; for it is almost always observed in the spaces of which we speak, that there are parts of the mass of air often of a very small extent where the motion is incomparably stronger than elsewhere. Nevertheless the irregularity in the distribution of the vibrating parts is not observed except in places, furnished, or of an irregular form; for in other places, and especially in long galleries, the vibrating zones appear to exist generally and regularly."—*Ann. de Chimie*, xxiv. 56.

II. CHEMICAL SCIENCE.

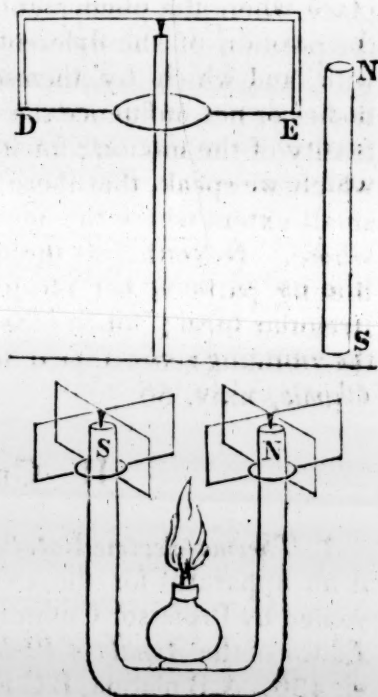
1. *Thermo-electric Rotation*, by Professor Cumming.—The following is an apparatus for the exhibition of thermo-magnetic rotation, invented by Professor Cumming, and described by him in a letter to the Editor of the *Annals of Philosophy*, N.S. vi. 436. A B platina, B C F D A silver, these are made into a parallelogram, which is afterwards bent into a semi-circular form. F E is a wire less than the radius of the curve, proceeding horizontally from the frame, and E is an agate cap by which the instrument may be suspended freely on a point. A lamp and magnet being placed opposite to each other are sufficient to produce rotation, but the effect is improved by adding another magnet at 90° from the first, having its poles in the contrary direction, and being connected with it by a bar of soft iron placed beneath them. With this arrangement the rotation will be from right to left, or from left to right, according to the position of



the lamp. The second magnet is placed near F G, having its N end upwards. If the lamp be beneath B, the rotation is in the direction B G A ; but if it be opposite to F G, the rotation is A G B. The apparatus without the agate cap weighs 4 grains.

2. *Thermo-electric Rotation*.—Mr. Marsh, of Woolwich, has also constructed a variety of apparatus for the exhibition of rotation by thermo-electricity. By the directions of Mr. Barlow, he endeavoured to make an apparatus according to the former instructions of Professor Cumming, but, failing almost entirely in making it act, he constructed some according to his own suggestion, which succeeded perfectly.

Fig. 1, will give an idea of this apparatus; the double line represents silver wire, the single line platina wire. They are soldered together and made into a rectangle, having a ring in the lower part for the introduction of the support. A fine point is attached to the upper part of the rectangle, and resting on an agate cap on the top of the support, allows of free motion. When the pole of a magnet was placed as in the figure, and a lamp applied at D, the instrument immediately moved round until the side E came to the flame, and then it moved back again, at last resting at right angles to the lamp and magnet. When a second magnet was placed in a similar position at D, and then the lamp applied either at D or E, rotation began, which was either in one direction or the other, according as the lamp was applied to one end or the other, and soon amounted to thirty revolutions in a minute.



Compound rectangles were then made, having four branches, and performed extremely well: the length of the rectangle is about two inches, the depth an inch, the diameter of the platinum wire $\frac{1}{80}$ of an inch, and that of the silver $\frac{1}{40}$. When two rectangles were arranged on the poles of a horse-shoe magnet, as in Fig. 2, and the lamp applied between them, they continue to revolve as long as the lamp remains burning.

Mr. Barlow has made many experiments with these apparatus, and finds them to accord perfectly with the laws he has laid down in his *Essay on Magnetic Attractions*. Some singular appearances of motion are produced with the compound rectangle, when the magnetic pole being considered as stationary, the lamp is applied beneath the four branches in succession, but they are all reducible to

one simple effect, and subject to one general law.—*Phil. Mag.* lxii. 321.

3. *Thermo-electric Phenomenon with Iron*.—Professor Cumming has remarked, that if in the compound piece of two wires used to produce electro-magnetic effects by heating, one of the pieces be iron, and they be heated by a spirit lamp, the deviation, in some cases, gradually attains a maximum, then returns through zero, and at a red heat assumes an opposite direction; resembling in this respect the deviations before observed with an alloy of antimony and bismuth. These effects took place when iron was connected with silver, copper, gold, zinc, and brass, but not with platina or lead, and has not been observed in other cases where neither of the wires were iron.

The table which we copied in our last Number of the relations of the thermo-electric bodies should be corrected, by having galena put above bismuth, and silver between zinc and ore of iridium and osmium.—*Ann. Phil., N. S.* vi. 321.

4. *Dobereiner's Eudiometer*.—Professor Dobereiner has suggested the use of finely divided platina for the purpose of detecting minute portions of oxygen in a gaseous mixture, in which hydrogen also is present. Its effect is immediate; the moment the substance rises above the surface of the mercury in the tube containing the mixture, the combination of the oxygen and hydrogen begins, and in a few minutes is completed; and, as Professor D. has stated, it seems capable of detecting the smallest quantity of oxygen. Its utility in the analysis of atmospheric air, and compounds containing oxygen, is obvious, provided no combination also takes place between the hydrogen in excess, and the nitrogen (or other gas) that may be present, as does in fact happen, according to Dobereiner, when protoxide of platinum is so employed.

Messrs. Daniell and Children mixed 20 measures of atmospheric air, with 37 measures of hydrogen gas, and passed up to the mixture a small portion of the platina powder, procured by heating the ammonia muriate to redness, and made into a ball with precipitated alumina. The pellet was heated red by the blowpipe, immediately before it was used, its size about that of a small pea. The absorption amounted to 13 measures = 4.3 oxygen, being 0.1 of a measure more than the quantity of oxygen in 20 measures of atmospheric air, which may probably have arisen from a slight impurity in the hydrogen, or from some minute unperceived bubbles of air, entangled in the mercury.

Another mixture of common air and hydrogen, in which the latter was in considerable excess, was deprived of its oxygen by the pellets, and when the absorption was complete, 38 measures of the residual gas were taken, and a fresh pellet, heated to redness, immediately before it was used, passed up. After standing about a quarter of an hour, no absorption had taken place. The tube and the mercury

were then placed before the fire, till the whole apparatus was too hot to be touched with the naked hand. It was then removed from the fire, and when cooled to its original temperature, the mixture occupied, as before, exactly 38 measures. The powder of platina with hydrogen seems, therefore, to be admirably calculated for eudiometrical purposes. Its application is extremely simple and easy, it is speedy in its effect, and no error need be apprehended from the formation of ammonia, even at considerably elevated temperatures. It appears also to be well calculated for ascertaining the purity of simple gases, at least as far as regards admixture of atmospheric air. The oxygen of a very minute portion of common air, mixed with carbonic acid gas, and a little hydrogen, was immediately absorbed, on passing up one of the little pellets to the mixture.

5. *On the Action of Platina on Mixtures of Oxygen, Hydrogen, and other Gases.*—We noticed in our last Number, p. 179, the singular experiments made by M. Dobereiner, on the ignition of platinum by a jet of hydrogen. Several papers have appeared since then, on the same subject, of the matter of which we purpose giving a very condensed account, in the following lines.

The preparation of platinum observed by Mr. E. Davy, which ignites in contact with the vapour of alcohol, is well known. M. Dobereiner*, by precipitating a solution of platina by sulphuretted hydrogen, and exposing the dry precipitate to the air for a few weeks, obtained an oxidized sulphuret, having similar properties, and further ascertained that both these substances enabled the alcohol to attract oxygen gas, producing acetic acid and water at the same time with the phenomena of ignition before referred to. By further experiments, it was ascertained that neither oxygen nor carbonic acid gas was absorbed by these two substances, but that every inflammable gas was; and 100 grains of the protoxide of platinum (Mr. Davy's substance,) absorbed from 15 to 20 c. i. of hydrogen gas with ignition of the substance, and also of the hydrogen, if previously mixed with air or oxygen. The preparation of platinum charged with hydrogen readily attracts as much oxygen as will combine with the hydrogen it contains, so that air being admitted, the oxygen instantly disappears; and even ammonia is formed, if there be not enough oxygen for the hydrogen in the platina. The platina immediately reduced, loses some of the properties it before possessed, but retains the power of determining the combination of hydrogen gas with oxygen gas, and with the evolution of so much heat, as, if the experiment be made properly, to ignite the platinum. M. Dobereiner immediately concluded that the platina obtained by heating the ammonia-muriate would have the same effect, and found his expectations confirmed by experiment. This experiment was made July 27, 1823.

M. Dobereiner considers the phenomenon as an electric one, and that

* *Annales de Chimie*, xxiv. 91.

the hydrogen and platina form a voltaic combination, in which the former represents the zinc. Another remarkable result was obtained with the oxidized sulphuret of platina. Placed in contact with carbonic oxide, the gas diminished to one half, and became carbonic acid; hence it is decarbonized by the solid substance. In a supplement to the paper just abstracted, in which M. Dobereiner describes the mode of making the experiment, as we have stated, by a jet of hydrogen, he mentions also, that he had applied it to the construction of a new apparatus for procuring fire.

In a further communication to the public*, on this subject, M. Dobereiner says, that the energy of hydrogen is so much increased by the presence of platina in powder, that it will in a few minutes completely separate one part of oxygen, from 99 of nitrogen, an effect which the strongest electrical spark will not produce. In these experiments, platina in powder is mixed with potters' clay, moistened, and made into small balls, about as large as a pea, these are dried and then heated to redness, one of these balls, weighing from 2 to 6 grains, will convert any quantity of detonating gas into water, and may be employed above a thousand times, if dried carefully after each operation.—The compound gases, containing hydrogen, do not combine with oxygen, when in contact with platina. A jet of hydrogen on the platina, precipitated by zinc from a solution, made it red hot, with a crackling noise and sparks; this powder is a mixture of platina and its oxide, and converts alcohol, when oxygen is present, into acetic acid. Nickel prepared from the oxalate, has the property of converting oxygen and hydrogen gases slowly into water.

MM. Dulong and Thenard†, have verified the experiment, of the ignition of platina by a jet of hydrogen, and have added some other facts on the same subject. They remarked, as M. Dobereiner had done, that introduced into a mixture of oxygen and hydrogen, it determined the combination of the gases sometimes with ignition; that the platina, strongly calcined, loses the property of becoming incandescent, but still slowly causes condensation; that finely-divided platina, obtained by other means, or wires, or laminæ, had no action at common temperatures, but that very thin leaf platina crumpled up together acted instantly, although the same leaf rolled round a cylinder of glass, or suspended freely in the gases, had no action; but the leaves, wires, powder and plates, all acted slowly at temperatures between 400° and 572° F. Palladium in thin pieces acted at an elevated temperature, as well as platinum of the same thickness. Rhodium caused the formation of water at about 464° F. Gold and silver, in leaf, acted at a temperature somewhat under that of boiling mercury.

* *Annales de Chimie*, xxiv. 91. *Bib. Univ.* xxiv. 54.

† *Annales de Chimie*, xxiii. 440.

Carbonic oxide and oxygen form carbonic acid; nitrous gas is decomposed by hydrogen at the common temperature, by contact with spongy platinum; and a mixture of olefiant gas, with sufficient oxygen is changed into water and carbonic acid at 572° F.

These philosophers then observe that certain metals have the property of decomposing ammonia, without absorbing either of its elements, at a temperature at which the ammonia by itself would be quite unchanged; 150 grains of iron wire are thus sufficient for decomposing nearly the whole of a rapid current of ammoniacal gas, continued for 8 or 10 hours, whilst thrice as much platina wire does not produce a like effect, even at a much higher temperature. These results depend, perhaps, on the same causes which make gold and silver effectual in combining oxygen and hydrogen, at 572° F., massive platinum at 518° F., and spongy platinum at common temperatures. Now as iron so well separates the elements of ammonia, and scarcely at all effects the combination of hydrogen with oxygen, whilst with platinum it is the reverse; the authors are induced to suppose that some gases tend to combine under the influence of metals, and others to separate, the effect varying with the nature of each; but they refrain from offering conjectures until supported by experiments.

MM. Dulong and Thenard, have also ascertained that spongy palladium will inflame hydrogen as platina does; that iridium in the same form became hot and produced water; that cobalt and nickel in masses, cause the gases to combine at about 300° F.; that cold spongy platina formed water and ammonia, with nitrous gas and hydrogen; and acted also on mixed hydrogen and nitrous oxide gases.

Mr. W. Herapath* has made experiments on this subject, most of which being of a similar nature to some of those already described, we omit to specify. His attention was particularly directed to the temperature at which the effect first began to take place, and he states as the results of his experiments on this point, that if the gases have a temperature of 55° , the platina requires a temperature so high as 98° to cause them to unite.

Mr. Garden of Oxford Street, has also experimented on this subject†, and has found, that the black powder, consisting of iridium and osmium, left when crude platina is digested in nitro-muriatic acid, if heated red hot and then suffered to cool, acts as well as spongy platina itself. He also ascertained that a jet of hydrogen cooled to 32° ; if thrown upon spongy platina cooled also to 32° , quickly heated it to whiteness, and became inflamed, a result which contradicts Mr. Herapath's statement, and shews that the limit of temperature at which spongy platina ceases to act on mixed oxygen and hydrogen gas has not yet been attained.

* *Philosophical Mag.* lxii. 286.

† *Annals Phil. N. S.*, vi. 466.

6. *Solar Light and Heat.*—Mr. Powel has been engaged for some time in experiments on solar light and heat. He has examined the heating power of the prismatic rays, but chiefly with respect to the effects, said to be produced, beyond the red end of the spectrum. He has found that such effects are really produced, but has accounted for their being observed in some cases and not in others, from certain differences in the coatings of the thermometers employed. He has concluded from a number of experiments with different coatings that this heating effect is similar in its relation to surfaces to common radiant heat, and differs essentially in this respect from the heating power *within* the spectrum. He has made other experiments from which the nature and origin of this effect, may, with great probability, be inferred. The details will soon be made public.—*Ann. Phil. N. S.*

7. *Benzoic Acid in the ripe Fruit of the Clove Tree.*—The clove is the flower bud of the *Eugenia Caryophyllata*, and the ripe fruit used formerly to be used in medicine under the name of *Antophylli*. In the latter, Mr. W. Bollaert has observed crystals of benzoic acid lining the cavity between the shell and kernel.

8. *Certainty of Chemical Analysis.*—We mentioned at page 164, the conclusions to which M. Longchamps had arrived, as the results of his experiments on the uncertainty of the means of chemical analysis, at present in the possession of chemists. His experiments convinced him that no certainty could be obtained. Mr. Phillips, who has also examined this question, considers the inferences of M. Longchamps as unsupported even by his own *Mémoire*, and from his own experiments is satisfied of their inaccuracy. Some sulphuric acid was diluted and divided into eight parts, four of these were precipitated by nitrate of baryta, and four by the muriate of baryta; the precipitates were carefully washed and dried, and then weighed, those from the nitrate were 128.7; 128.0; 128.3; 128.6 grains, mean 128.4: those from the muriate, 128.1; 128.7; 128.0; 128.5; mean 128.325. These results are certainly very different to M. Longchamp's.—*Ann. Phil., N.S., vi., 289.*

9. *Correction of bulk of Gases for Temperature.*—Some of our elementary treatises on chemistry contain an inaccurate mode of estimating the change of bulk in a gas, occasioned by variation of temperature. They have directed that the bulk of the gas be divided by 480, the quotient multiplied by the number of degrees by which the temperature of the gas differs from the temperature to which it is to be reduced, and the product added, or subtracted, according as the actual temperature is below or above that referred to. But as the expansion of a gas, for each degree of Fahrenheit is $\frac{1}{480}$ of its bulk at 32° only, and at no other temperature the above rule is not

correct, except for cases where gas at 32° is to be estimated at some other temperature. Mr. Biggs has pointed out this error in the *Annals of Philosophy*, vi. 415, and has given the following more correct rule. Add the degrees which the gas is above 32° to 480, add also the degrees which the required temperature is above 32° to 480, then as the first number is to the second, so is the volume of the gas to the volume required. Another rule for making the correction is, to add the number of degrees between 32° and the temperature of the gas to 480, divide the volume of the gas by the sum, and multiply the quotient (which will be the expansion for each degree) by the number of degrees between the temperature of the gas, and the required temperature; if the latter be greater than the former, add the product to the volume of gas, if it be less subtract it, and the corrected volume will be given.

10. *Supports for Ignition of Particles by the Blow-pipe.*—The sappare is a substance recommended by M. de Saussure, for the support of minute particles intended to be subjected to the action of the blow-pipe, but is seldom used in consequence of the difficulty of making the particle adhere to it. In place of the water, saliva, or gum-water, generally used, Mr. Smithson recommends the use of a mixture of water and refractory clay; a little of the moist clay is to be taken up on the end of the splinter of sappare, and the particle to be heated being touched by it adheres, the whole is laid aside for a few minutes, and is then dry and may be heated. Mr. Smithson also recommends small triangles, or slender slips of baked clay in lieu of sappare, which is not always to be had. Another more recent process is, to file the very end of a platina wire flat, place the minutest portion of the moist clay on it, and then touch the particle to be heated. In a few moments it is dry, and may be put into the flame without flying off, unless too much clay has been taken.

Mr. Smithson points out a remarkable difference between quartz and flint before the blow-pipe. Quartz is almost refractory, but flint fuses with facility, swells, and even froths. It is asked whether flint does not, like pitch-stone, contain bitumen, which at a certain heat tends to tumefy it?—*Ann. Phil. N. S.* vi. 412.

11. *Solubility of Substances induced by Tartaric Acid.*—The following observations on solubility conferred by tartaric acid, are given in a note by M. Rose, in a Memoir on Titanium. “It is known that a solution of peroxide of iron containing tartaric acid, cannot be precipitated by caustic alkalies, by their carbonates, or succinates; its presence is indicated only by tincture of galls, ferro-prussiate of iron and hydro-sulphurets. I thought, therefore, I should obtain an oxide of titanium perfectly pure, by mixing tartaric acid with a solution containing the oxides of iron and titanium, and then adding ammonia to precipitate the oxide of titanium. But I found that many solutions

of oxides containing tartaric acid could not be precipitated by alkalies or their carbonates, though they fell immediately if that acid were away. Among these is the oxide of titanium, which is not then precipitated by the alkalies or carbonates; also alumine, of which the presence cannot be discovered in a solution containing tartaric acid; oxide of manganese, oxide of cerium, yttria, oxide of cobalt, oxide of nickel, magnesia, protoxide of iron, oxide of lead, when the solution contains nitric acid to keep the tartrate from precipitating, oxide of copper, and finally oxide of antimony, of which the solutions containing tartaric acid are not precepitated, either by alkalies or any abundance of water. I have employed this property of oxide of antimony with much success, in the analysis of the salts and ores of that metal. Though oxide of bismuth does not possess this property, it does not afford a means of separating it exactly from oxide of antimony. There is scarcely any acid but the tartaric which possesses this remarkable property of forming salts with many oxides, which cannot be precipitated by the alkalies. The phosphoric and arsenic acids are the only ones which in this respect, present any analogy.—*Ann. de Chim.* xxiii. 356.

12. *On two New Coloured Test Papers.*—The following account of these test papers is abridged from the description given of them by M. C. Pagot des Charmes, who has used them for many years with advantage in testing for acids and alkalies.

The first is obtained from the violet pellicle, which covers the root of the small radish, (*raphanus sativus oblongus*,) the second from the skin of the common red radish (*raphanus vulgaris*.) The directions with respect to the small radish, are to scrape off the coloured skin with a knife, and as it soon changes in the air, to collect them rapidly, put them in a piece of clean linen, and compress them, when a clear transparent blue fluid will be obtained. This test fluid may be preserved as it is out of the contact of air, or made into a syrup, or laid on paper by a brush; and the paper thus prepared, preserves its fine sky-blue colour in contact with the air for any length of time. This test is extremely sensible to acids and alkalies.

The scrapings of the common radish require to be bruised in a mortar before pressure; they do not yield so much juice, but the tint is very fine either in the fluid state, or on paper, and the test it affords is a very delicate one. These preparations are recommended above litmus, by their being equally sensible, and yet unaltered in the air, and by being readily obtained every where.—*Jour. des Phys.* xcvi. 136.

13. *On the Presence of Ammonia in Rust of Iron, formed in habited Houses.*—M. Vauquelin was called upon to examine some red spots found on a sabre, which was supposed to have been used in the commission of a murder, the spots being produced by blood; a small

portion of the red matter was introduced into a glass tube, closed at one end and heated, the other being occupied by a strip of litmus paper, reddened by an acid; a yellow vapour rose, from the substance which changed the red colour of the paper to blue.

A second experiment was made with the matter of some red spots found on a knife which was supposed to have been put to the same use as the sabre, being found in the house where a murder had been committed, and exactly the same results were obtained.

These facts tended to strengthen the suspicions previously raised; but although a medical man did not hesitate to assert that the spots were actually blood, yet they resembled rust much more than blood. The experiment was therefore repeated with common rust from a piece of iron found by accident in the judge's cabinet; this rust gave exactly the same result as the former, and the suspicions before existing were of course destroyed.

The fact proves that rust formed within houses is capable of absorbing and strongly retaining the ammoniacal vapours there developed. It also absorbs animal vapours, for in all these experiments vestiges of a brown oil were constantly observed on the surface of the tube.

M. Laugier has confirmed this result with rust found in his laboratory, and has further observed the development ultimately of sulphuric acid in the experiment.—*Ann. de Chim.* xxiv. 99.

14. *New Carburetted Hydrogen Gas.*—M. Clement states as information which he had received directly from Mr. Dalton, that the latter chemist had found a new carburetted hydrogen gas in oil gas. This new gas contains twice as much carbon as olefiant gas, and has been named by Mr. Dalton super-olefiant gas. There is a great quantity of it in oil gas.

In reference to this subject we may refer our readers to a paper in the *Annals of Philosophy*, N.S. iii. 37, where a gas of the same chemical composition as olefiant gas, but of twice its density, is, from the experiments of Dr. Henry, inferred as existing in oil gas.

15. *On Titanium*, by M. Rose.—Oxide of titanium was obtained pure by fusing powdered rutilite with thrice its weight of carbonate of potash, dissolving the compound in muriatic acid, precipitating by caustic ammonia, digesting the precipitate for a certain time with hydro-sulphuret of ammonia, and then digesting the solid matter left in weak muriatic acid, which leaves the oxide of titanium pure. In this way only as yet can the iron be removed. The pure oxide remains perfectly white when heated and cooled, and is then untouched by acids; fused with carbonate of potash, and then treated with muriatic acid, it sometimes gelatinizes, though not so strongly as silica. It becomes red by touching moistened litmus, and with alkalis

acts precisely as an acid. It has therefore been called by M. Rose, titanic acid.

Titanates. When fused with carbonate of potash in excess, two substances are obtained in the crucible; the upper is the excess of carbonate, the lower the neutral titanate of potash. In neutral titanate thus prepared, the oxygen of the acid is to that of the base as 2 to 1, and as titanic acid was found by calculation from experiments on the sulphuret of titanium, to contain 33.95 per cent. of oxygen, its capacity of saturation was considered consequently as being 16.98.

These neutral titanates are decomposed by water, which removes part of the potash, and leaves insoluble acid titanates. The acid titanate of soda contained titanic acid 83.15

Soda . . . 16.85

100.

acted on by muriatic acid, a further portion of soda was removed leaving a salt composed of titanic acid 96.38

Soda . . . 3.62

100.

The acid titanate of potash gave titanic acid 82.33

Potash . . . 17.77

100.

There are no salts with base of titanic acid; those compounds which have been taken for such, resulted from the presence of alkali in the titanic acid; but when the acid titanate of potash is dissolved in muriatic acid and diluted, precipitates may be obtained by adding the sulphuric, arsenic, phosphoric, oxalic, and tartaric acids, which are binary compounds of these acids with titanic acid. The compound with sulphuric acid when heated, yields pure titanic acid; when moderately dried, it strongly attracts moisture from the atmosphere. It contains

Titanic acid . . . 76.67

Sulphuric acid . . . 7.67

Water 15.66

100.00.

The compound with oxalic acid contains

Titanic acid . . . 74.10

Oxalic acid . . . 10.40

Water 15.50

100.00

Sulphuret of Titanium.—M. Rose did not succeed in reducing titanium: but by passing the vapour of sulphuret of carbon over it at a very intense heat, succeeded after many trials in forming an uniform and perfect sulphuret. It was of a deep green colour, and on the

slightest touch with a hard body, exhibited a strong metallic lustre, similar to that of yellow copper. Heated with access of air it burnt, producing sulphurous acid and leaving titanous acid. Nitric acid converted it into titanous acid, liberating sulphur. When analyzed by combustion it gave as its elements

Titanium	. . .	49.17
Sulphur	. . .	50.83
		100.00

and for the elements of titanous acid

Titanium	. . .	66.05
Oxygen	. . .	33.95
		100.00.

As a test that the degree of oxidation in titanous acid corresponds with that of the sulphuration in the sulphuret, a portion of the latter was boiled in solution of caustic potash; the sulphuret was soon decomposed, and titanate of potash was deposited; and the liquor being acted on by muriatic acid, gave sulphuretted hydrogen without any deposition of sulphur.—*Ann. de Chim.* xxiii. 353.

16. *Cadmium from Zinc Works*.—Mr. Herapath formerly stated the presence of cadmium in the zinc works of Bristol, (see vol. xiii. p. 427.) He finds that if the powder there referred to be introduced into an iron bottle and tube similar to that used for obtaining oxygen from manganese, a piece of paper pushed down upon it, and the apparatus placed above the neck in any furnace or fire-place, where a bright red heat can be produced; the cadmium will be found in the cold part of the tube, or resting on the charred paper, if a larger quantity has sublimed than can support itself. It now exists in small globules, and may be obtained in a button, in the way formerly described. It is requisite that paper or some substance be introduced to remove the oxygen of the atmosphere in the bottle. After this process the powder still contains cadmium, which may be separated by solution in muriatic acid, and precipitation by zinc; iron and cadmium precipitate and the mixture distilled as before furnishes more cadmium.

The sulphuret is proposed as a pigment nearly equalling in beauty the chromate of lead.—*Phil. Mag.* lxii. 167.

17. *Alloy of Zinc and Iron*.—This alloy was collected by M. Herapath in a zinc manufactory at Bristol. It lined the tube leading from the retort. It was hard and brittle, the fracture shewing broad facets like zinc, but of a duller grey colour, with surfaces more rough and granular. Its specific gravity 7.172. It was composed of 92.6 zinc, and 7.4 iron per cent.—*Phil. Mag.* lxii. 168.

18. *Muriates of Baryta, Strontia, and Lime.*—Mr. Phillips has examined the various statements given of the composition of the salt sometimes called chloride of barium, and sometimes muriate of baryta. Although the relative proportions of chlorine and barium existing in it as a chloride, and of muriatic acid and baryta afforded by it when considered as a muriate, have been ascertained with considerable precision, yet the accurate proportions of the crystallized salt have not been stated. Mr. Phillips, on a careful comparison of the various analysis that have been made, states its composition to be as a chloride,

1 atom chloride barium	106	Chlorine	29.03
2 — water	18	or Barium	56.45
		Water	14.52
	124		
			100.00

or as a muriate,

1 atom mur. barytes .	115	Muriatic acid .	29.84
1 — water	9	or Barytes	62.90
		Water	7.26
	124		
			100.00

The equivalent numbers of crystallized muriate of strontia are

$$\begin{array}{l} 1 \text{ atom chloride stront. } 36 + 44 = 80 \\ 6 \text{ — water } 9 \times 6 = 54 \end{array}$$

134

$$\begin{array}{l} \text{or } 1 \text{ atom mur. strontia } 37 + 52 = 89 \\ 5 \text{ — water } 9 \times 5 = 45 \end{array}$$

134

The equivalent numbers of crystallized muriate of lime are

$$\begin{array}{l} 1 \text{ atom chloride of calcium } . . 36 + 20 = 56 \\ 6 \text{ — water } 9 \times 6 = 54 \end{array}$$

100

$$\begin{array}{l} \text{or } 1 \text{ atom mur. lime } . . 37 + 28 = 65 \\ 5 \text{ — water } 9 \times 5 = 45 \end{array}$$

110—*Ann. Phil. N.S.* vi, 339.

19. *On a Quadruple Salt.*—Whilst separating cadmium from the metals which always accompany it, M. Tassaert had occasion to observe the formation of a singular salt. The ore of zinc had been dissolved in sulphuric acid and ammonia added, but not to neutralization; a plate of zinc was then added, which, after some time, was found covered with colourless transparent crystals. These, separated and examined, were found to contain ammonia, sulphuric acid, oxide

of iron, oxide of zinc, and water : when analyzed, the following proportions were obtained :—

Water of crystallization	30.90
Sulphate of iron	3.16
Sulphate of zinc	39.00
Sulphate of ammonia	26.94
	100.00

The water of crystallization surpasses the quantity which would be required by the sulphates separately, and this fact is adduced by M. Tassaert, as an argument in favour of the whole being the result of chemical combination, and not a mere mixture.—*Ann. de Chim.* xxiv. 100.

20. *Pyrophorus from Tartrate of Lead.*—Dr. Gobel, whilst working with the tartrate of lead, remarked that when heated in a glass tube, a very perfect and beautiful pyrophorus was produced. When some of the dark-brown mass thus formed was shaken out into the air it immediately inflamed, and brilliant globules of lead covered the ignited surface : some of these changing by degrees into litharge, offered a very beautiful appearance. The ignition continues much longer than with other pyrophori, which circumstance, with the facility of preparation, may make it a convenient means of obtaining fire.

The inflammation of these substances, as Dr. Gobel remarks, has been attributed principally to the presence of potassium, but this substance affords a new proof that other metallic compounds are susceptible of spontaneous inflammation on the accession of air.

21. *On a Green Pigment.*—The preparation of a beautiful green colour is described in our last volume, at p. 309 ; but an easier process for the production of the same colour having been given by Dr. Liebig, we insert it beneath. A given weight of verdigris is to be dissolved by heat in a copper vessel in a sufficient quantity of pure vinegar, and then an aqueous solution of an equal quantity of white arsenic added ; generally a dull green precipitate falls, which must be redissolved by adding more vinegar. The mixture is then to be boiled, and after some time a crystalline precipitate appears, of the finest green colour, which, separated, washed, and dried, is the substance in question. If the liquor still contains copper, arsenic is again to be added ; or if it contains an excess of arsenic, the preparation of copper must be added, and the process carried on as before. Sometimes the liquor contains an excess of acetic acid, and may then be employed to dissolve verdigris, as at first.

Thus prepared, the colour has a bluish tint, but it may be obtained of a deeper and more yellow tint, yet with the same brilliancy and beauty ; for this purpose a pound of common pearlash is

to be dissolved in a convenient quantity of water, ten pounds of the colour obtained as above added to it, and the whole heated over a moderate fire; the colour will soon change and take the tint required. If boiled too long, the colour approaches that of Scheele's green, but always surpasses it. The alkaline liquor remaining may be used in the preparation of Scheele's green.—*Ann. de Chim.* xxiii. 412.

22. *Peculiar Effects of burning on Limestone or Chalk.*—M. Vicat, of whose excellent work on Cements and Mortars we gave a short account, vol. x. p. 407, has lately obtained some singular results in the burning of lime. Many years since he observed, whilst burning pure lime with charcoal and coal in a small furnace, that if the fragments of lime on passing through the furnace into the ash-pit, were again put in with fresh fuel, and this many times successively, a lime was obtained incapable of slaking, but which, broken up and made into a paste, had the remarkable character of setting under water.

It is an old opinion among lime-burners that limestone which has cooled before it has been completely burnt, cannot by any quantity of fuel be converted into quick lime, and M. Vicat considers this opinion as supported by the experiment above. It appears to result, M. Vicat says, that pure calcareous matter, as chalk or marble for instance, may be brought by fire into an intermediate state, being neither lime nor a carbonate, and that in this state it has the property, when pulverised and made into a paste, of setting under water.

Chalk converted into lime, and slaked in the usual way, yields a hydrate, which, made into a paste, will not harden in water; but the same lime left to fall into powder by long exposure to the air, and then made into a stiff paste with water, will solidify very sensibly after immersion. The action of the air here occasions the formation of a compound analogous to that afforded by imperfectly burnt chalk, being like that, neither completely lime or completely carbonate; and it enjoys the same hydraulic properties.

Ten equal portions of finely-powdered chalk were taken, and a plate of cast iron being heated red hot, they were placed upon it; one portion was allowed to remain three minutes, another six, a third nine, and so on, and during the time they remained on the plate they were continually stirred, that all parts might be equally calcined. These portions were mixed up, with a small quantity of water, into pastes of equal consistency, no signs of slaking were observed; the first portions gave the ordinary odour of moistened chalk, the latter portions gave the alkaline odour belonging to lime, and were decidedly alkaline. After twenty-four hours of immersion in water all the numbers, except the first had set, as hydraulic lime would have done, and became harder daily, whilst the first remained soft. When, after some time, the comparative hardness of the second and the tenth were tried, no apparent difference could be perceived.

Viewing these substances as mixtures, in various proportions of lime and carbonate of lime, M. Vicat thought it probable they might be imitated, but no mixture made by adding lime and carbonate of lime, to each other, gave the least signs of solidification under water.

Very analogous results to these were obtained by M. Raucourt de Charleville; but the most remarkable effect was observed when the fuel used was charcoal. He had prepared a mixture of pure lime and clay, which, when dry was broken into small pieces, and burnt, either on a heated plate or in a furnace, all the results furnished hydraulic lime, except those which had been burnt in contact with charcoal. Hence, observes M. Vicat, the contact of the charcoal had deranged the action which occurs between lime and clay in the ordinary mode of burning, and presents a phenomenon very difficult to explain. At first, it might be supposed that the iron required per-oxidation, before it would combine with the lime, and that the charcoal prevented this; but the experiments of M. Berthier prove that the iron is nearly passive in these and similar cases.—*Ann. de Chim.* xxiii. 424.

In addition to these experiments, it may be remarked, that M. Clement, whilst stating the occurrence of a substance in France fit for the fabrication of Roman cement, and which was discovered by M. Minard, gives an opinion formed by M. Minard, from many experiments, "that Roman cement owes its quality to a sub-carbonate of lime, produced by the action of fire on the natural carbonate."—*Ann. de Chim.* xxiv. 106.

23. *New vegetable principle, Dalhine.*—M. Payen has discovered a new substance in the bulbs of the *Dalhia*, which has been called *dalhine* and besides it, an uncrystallizable sugar, aroma, a volatile, and a fixed oil, albumen, silica, and several calcareous salts.

To extract the *dalhine*, the pulp of the bulbs is to be diffused in its weight of water, filtered through cloth, the liquid mixed with one twentieth its weight of common chalk, boiled for half an hour, and filtered. The residuum of the bulbs is then to be pressed, the solutions united and evaporated to three fourths of their volume; 4 per cent of animal charcoal must then be added, and the whole clarified by the white of an egg. The liquor filtered and evaporated, until a film form on the surface, deposits *dalhine* on cooling. All the washings are to be treated in the same way and thus 4 per cent of *dalhine*, will be obtained from the bulbs.

This substance when pure, is white, inodorous, pulverulent, tasteless, of a specific gravity 1.356, more soluble in hot, than in cold water, not soluble in alcohol, but precipitated by it from aqueous solutions. Potash dissolves it, ammonia does not, sulphuric acid converts it into an uncrystallizable sugar more sweet than that of starch.

This substance has some analogy with starch, inulinè, gelatine, &c., but differs from them in forming a granulated mass when its aqueous solution is evaporated, by its specific gravity, and other qualities.—*Ann. de Chimie*, xxiv. 209.

III. NATURAL HISTORY.

1. *Amici's Microscopical Observations*.—Professor Amici, of Modena, has published the results of his microscopical observations on various plants, in the *Proceedings of the Italian Society of Sciences at Modena*. We have only seen an account of these researches in the *Bibliothèque Universelle*, xxiii., and have made the following abstracts from it. The work of Amici is illustrated by several large plates, of the accuracy of which, and also of the descriptions, his abilities and means are securities.

Circulation of the Sap in Vegetables. Caulinea fragilis.—Corti first discovered the motion of the sap in plants, and among others in an aquatic plant of which he has not given the name, but only an imperfect figure; it proved to be that of which Wildenow made a genera under the name of *Caulinea*. Some time since Amici observed and described a similar phenomenon, in the *chara vulgaris*: the circulation was seen in the vessels of this plant, always in the same direction, and was supposed to be caused by small crowns of green particles lining the internal membrane of the tube.

A transverse section of the *Caulinea*, viewed by powers of 60 and 150, appeared as a polygon of 8 rays, each formed by a range of circular bodies; the centre was occupied by a large tube, surrounded by a bundle of smaller tubes parallel to each other, and in which were diaphragms at a considerable distance one from another. These vessels contained only air, which escaped in bubbles, when they were cut under water; all the other apertures in the section, are those of the vessels which conduct the sap, and which also have diaphragms, more or less distant from each other. No proper trachæ or porous tube was discovered.

Each cavity of the *Caulinea* formed a particular vessel, in which the liquid moved, independent of the circulation in the neighbouring vessel, and in a manner analogous to the movements before observed in the vessels of the *Chara*. The fluid contains visible concretions which moving with it indicate its course, and the velocity of its motion in different parts. These particles are globular, of the same size in the same vessel, but varying in different parts of the plant. The motion is as follows:—globules ascend on the one side of the tube containing them and the liquid until they reach a diaphragm, when they move horizontally to the opposite side, and descend, until coming to a diaphragm beneath, they move horizontally in the

opposite direction to the first horizontal motion, and again ascend as before. This effect continues as long as the plant is alive. All the globules are not in contact with the surface of the tube; those which are at some little distance, circulate as well as the others, but less rapidly; and their motions were slower, as they were nearer to a plane, which may be supposed to pass through the tube, and separate the two currents. Sometimes the globules displaced each other, at other times they passed from the one side to the other, before they reached the diaphragm. The directions of the motion in two parallel and contiguous vessels appeared to have no relation to each other. The rapidity is variable, according to the size and length of the canal, and the degree of injury it may have suffered in preparing it, a complete circulation has been observed in a vessel $\frac{1}{3}$ of a line, in length, in 30", this velocity is not more than a third of that observed in the *chara vulgaris*. It is to be remarked that when the plant is cut, to submit it to observation, the circulation is suspended for a time and requires some hours to be renewed.

The circulation of the sap takes place in the cellular tissue as well as in the vessels, the globules move along the surface of the cell, changing their direction when they arrive at the angles of the polygons. Sometimes a mass of globules collect in the centre and rotate with a motion common to the whole. Observations on the leaves are more delicate, than those on the stalks of the plants, they require to be made whilst the leaf is attached to the plant, and the light must be thrown from above, as for opaque objects.

Thus each vessel presents two currents, one ascending, the other descending, which are not separated by any division: the interior is studded with small crowns, composed of particles which are very difficult to discover, because of their tenuity and transparency, and the nature of the motion shews it to arise from the surface of the tube, and precisely from those points occupied by the crowns, for there may be observed the maximum of the velocity with which the globules move.

M. Amici does not state that no liquid passes from one cavity to another, he is indeed convinced of the contrary; but the transfusion takes place through invisible apertures, through which the globules cannot pass. He has remarked two varieties of limpid fluid in the *Caulinea*, one white and one red, contained in different vessels, though of the same form. He attributes the distinct green colour of the plant, to globules very green themselves, floating in the fluid; they are greener towards the exterior of the plant, than in the interior. There is this difference between the *Chara* and the *Caulinea*, that in the first the globules are white, and the particles of the small crowns green, the latter colour the plant; but in the second, the globules are green, and the crowns yellow. Oil and alcohol do not alter the form of the globules of the *Caulinea* but discolour them entirely.

Chara flexilis. The organization of this plant is exceedingly simple, a section of the root, the trunk, the branches, or the leaves, pre-

sents but a single circular aperture belonging to a tube transparent as glass, and furnished in the interior with small crowns of green particles as in the *Chara vulgaris*. This tube contains a colourless liquor and white globules of various dimensions, some of them far surpassing, in size, the green globules adhering to the surface. These appearances are easily perceived, without any preparation of the plant, and with a common microscope. This plant has flowers, in the organs of which the circulation of the sap may be perceived in all their stages. The regular order preserved in the tubes by the two series of crowns, those of the ascending, and those of the descending, side is very remarkable and evident. The circulations in the vessels are independent of each other, so that if one is injured, the others still preserve their functions.

Of the Pollen. The principal object of M. Amici, under this head, is to describe a phenomenon, which he is anxious should be verified by other naturalists, but he forewarns them that a linear power of 300 is necessary for its observation; the drawing he has himself given was from a specimen magnified 1000 times. The Pollen was from the *Portulaca oleracea*. The figure represents a globe, $2\frac{1}{2}$ inches in diameter, attached laterally to a curved tube, which descends vertically; between the tube and the globe and in contact with both is the superior extremity of a hair of the stigma, which forms also a transparent tube, filled with small corpuscles circulating slowly in it. On first observing it the author remarked nothing particular, but on a sudden the globe opened, and a tubular tail extended from it, which passing above the extremity of the hair of the stigma returned beneath it, thus applying itself to it and doubling its diameter; the membrane forming this tube was very transparent. This tube was filled with globules, which after circulating through it, passed into the globe of pollen, which itself was full of corpuscles in motion, and fresh globules supplied their places from it. The same kind of motion was observed in the vessels of the stigma. This phenomenon continued for three hours, after which time the corpuscles disappeared from the tube. M. Amici could not decide whether they had returned to the globe, or entered the cells of the stigma, or been otherwise disposed of.

It is necessary to an observation of this kind, that the flower be gathered a short time before it fades, the interior pistil separated and placed under the microscope; the most favourable light is that of the sun: if then the globules of pollen already adhering to the extremities of the hairs of the stigma, be placed at the focus of distinct vision, and all humidity excluded, they will appear perfectly spherical, but shortly they will be seen to explode and develop the tube-like tail, and the phenomena will appear as above described. The effect takes place more readily as the weather is warmer. The flower gathered about eight A.M., preserves for nearly three hours the power of exhibiting this phenomenon.—M. Amici considers the globules

which he saw circulating in the tail, as the same as those which other observers have remarked as a little cloud, when a globe of pollen has been broken.

The pollen of the flower of the *cucurbita pepo*, are globes, which when moistened presented, at different points of their surface, very transparent vesicles, at the summit of which were adapted small opaque covers with a projecting spine in the middle; this cover appears to act as a valve whilst the vesicle is within the globules. If the pollen be dipped in alcohol, before being placed in water they do not break, and the phenomena of the vesicles are better observed.

The pollen of the *cichorium inlybus* is of a regular dodecaëdral form, with pentagonal faces; put on to water it bursts at one of the faces and throws a liquid to a distance twice its own diameter, some of the other faces swell and produce vesicles, analogous to those before mentioned, but without the operculum.

On the Epidermis. The epidermis of the leaves of a great number of plants examined by M. Amici, is a tissue formed of a layer of cells, independent of those of the parenchyma which are covered by it. It is white, transparent, and may be removed without laceration of the subjacent parenchymatous layers, of which each has its particular membrane, which adheres only by contact to the epidermis.

M. Amici refutes the opinion of those who affirm the common nature of these two substances, by pointing out that in many cases (*dianthus caryophyllus* for one,) the cells of the epidermis are quadrilateral, whilst those of the parenchyma are cylindrical tubes, of various lengths, perpendicular to the plan of the epidermis. But these vary in different plants, and are sometimes very singular. The difference in the figures of these cells may readily be seen without removing the epidermis, by only changing the focus of the microscope by a quantity equal to the thickness of the epidermis; they are thus presented alternately to the eye, and their want of correspondence made evident. The spaces which the varied dispositions of the parenchyma produces are filled with air; and they correspond with areas of an oval form in the epidermis, in the centre of which may be observed apertures, sometimes open and sometimes closed. In leaves of the *ranunculus repens* and *ruta graveolens*, the organ terminated by these orifices is a small bag or purse, which is opened or closed by a sphincter according to circumstances, not merely spontaneously in the living plant, but at the will of the observer. They are generally open in sun light, closed in darkness; large when the leaf is dry, narrow when it is moistened. In the *ruta graveolens*, when the pores are open, the parenchyma composed of small green tubes may be seen, when closed the green disappears, and the orifices take an ash colour.

With regard to the functions of these pores, it is concluded, that they are not intended for absorption of water, because they close

when moistened, and open to light and dry air; because roots and plants living under water have them not, floating leaves have them only on their upper surface; and because (with reference to rain and dew) they are more abundant on the under surface of leaves, than on the upper. That they are not intended for evaporation is assumed, because the plant being separated from the root they close, although evaporation still goes on. That they are not excretory organs, appears from their corresponding with cavities containing neither fluid nor solid matter. It is therefore concluded that they are intended for the passage of air, but whether for its entrance or exit is difficult to determine. At night when the large pores of the epidermis are closed, the leaves absorb the carbonic acid dissolved in the dew, whilst by day when they are open, the same leaves decompose the gas; hence, perhaps, they may be destined, M. Amici thinks, to the emission of the oxygen gas resulting from this decomposition; an opinion favoured by the remark of M. De Candolle, that the corolla which has no pores produces no oxygen.

Mode of Union in the vegetable Structure.—It has been a question whether the vessels of plants are all constructed of one continuous and single membrane, or whether each vessel has a complete membrane of its own. M. Amici in examining this point has not only ascertained the latter to be the case, and shewn that the membrane between two vessels is in consequence always double, as well at the diaphragms as at the sides; but has shewn that they frequently are really separated, having curved surfaces and spaces between them: these intervals never contain any thing but air, and they put the existence of the *vasa revehentia* of Hedwig, and the *meatus intercellulares* of Link beyond doubt.

On the Air Vessels of Plants.—M. Amici considers every vessel or vacuity whatever may be its form, tubular or cellular, in which the microscope discovers orifices, or openings more or less long, as air vessels. This class comprehends the spiral vessels, the false trachæ, the porous tubes, the vessels with false partitions, those with small crowns, those with false cells, and a great variety of others. A recent section of a plant shews these vessels empty and dry, and very distinct from the fibrous vessels, and the cells containing their respective juices; and if the section be put under water, air is seen to issue from them.

There are cases when the elastic fluid in these vessels cannot have been obtained from the atmosphere, as in the *caulineæ fragilis*, which grows under water. The author thinks it possible that the small crowns discovered in the interior of the sap vessels, may, perhaps, be the organs by which the air is in these cases separated from the water.

It is a constant law in the general system of vessels, that those which are fibrous surround those which are aëriform. In ligneous plants nature has substituted other channels for the intercellular pas-

sages found in the herbaceous plants, these are the medullary rays of which an example is offered by the hemp, which may be seen by three sections, one transverse, one down the axis of the plant, and a third parallel to it, but on one side. The *asclapias syriaca* offers a similar structure.

M. Amici believes that in all vegetables, water and their own fluids pass into the vessels through pores in their respective membranes, which the eye cannot discover, but which many facts prove to exist. He affirms the integrity of the vessels during the whole existence of the plant, and denies any change in their nature. As to the question whether the spirals of trachæ are themselves tubular, and conduct sap, he thinks it undeterminable until the optical means we possess, are such as to develop the structure of the vegetable membrane, for the dimensions of the spiral of the trachæ does not exceed the thickness of the membrane of the other tubes, in which as yet no one has found vessels containing fluids.

2. *Dry Rot.* We have been favoured by Mr. Baker of Hampstead, with some valuable observations on the above subject, which want of room prevents our publishing in detail. He adduces a number of instances, in which the following application effectually prevented the disease, and cured it where it had made considerable ravages.

Take two ounces of white arsenic in powder, dissolve it by boiling in one gallon of soft water; if boiled in an iron or tinned vessel, add half an ounce of copper filings, but if in an untinned copper vessel the filings are not necessary; to a quart of size and half a pound of common tar, add a small quantity of fresh-slacked stone-lime, sifted pretty fine, beat them well into a paste, which should be then nicely dissolved with the above solution, gradually adding during the process (by small portions,) as much more of the pulverized lime as will give the whole a proper (rather diluted) body, to be laid on with a painter's brush. New work when finished as a preventative should be dressed with the composition, at least twice after well drying the first coat; old work as a curative when removed and repaired, (such as diseased wainscott) should be perfectly dried by exposition to the air, and then well dressed on its back before it is returned to its place.

3. *Insects in Amber.*—M. Schweigger having very attentively examined the insects contained in the bits of yellow amber of the coasts of Prussia, and which at first sight might be thought to be the same as the present insects of that country, has found that they in fact often belong to the same genera, but not to the same species as those living in the present day. Among the small number of insects described and figured in the work of this author, we observe in particular an unknown species of scorpion, and a spider which differs from all the

species living at present, in not having the head of a single piece with the thorax. M. Germar, professor, at Halle, has given the result of a similar investigation in an *Entomological Journal*, where he tries to determine some species of those amber insects, the analogies of which are not found alive at the present day.—*Edin. Journ.* ix. 408.

4. *Analyses by M. Arfwedson.*—Cinnamon stone of Malsjö :

Silica	41.87	38.8
Alumina	20.57	21.2
Lime	33.94	31.25
Oxide of Iron	3.93	
Oxide manganese and magnesia	.39	

100.70

Brazilian chrysoberyl-Alumina . .	81.43
Silica	18.73

100.16

Boracite from Lüneburg-boracic acid . .	69.7
Magnesia	30.3

100.0

Borax, deprived of its water of crystallization, consists of

Boracic acid	68.9
Soda	31.1

100.0

The borates were analyzed by being mixed with three or four times their weight of finely-powdered fluor spar free from silica, and a sufficient quantity of sulphuric acid ; on evaporating the mixture and exposing it to a red heat, all the boracic acid was expelled as fluoboric acid gas. The quantity of base was then determined in the usual way.

5. *Loose Crystals in a Cavity in Quartz.*—Dr. Brewster has remarked the existence of a group of moveable crystals of carbonate of lime lying in a fluid in a cavity of a quartz crystal from Quebec, now in the collection of Mr. Allan. The crystal was perfectly sound about the cavity, which was of a triangular form, one side being about the tenth of an inch long. The fluid was transparent, and as it did not expand much by heat, was probably water. The crystals were transparent to a considerable degree, and had a white milky tint when viewed by reflected light. Their composition is inferred from the presence of

similar crystals in other specimens of quartz, which have been ascertained by experiment to be carbonate of lime. Some years ago Dr. Brewster had occasion to remark the existence of spherical groups of white crystals, both in the solid mass of quartz crystal from Quebec, and in cavities in them; these exactly resembled the crystals in Mr. Allan's specimen, and when analyzed, were found to be calcareous spar.—*Edin. Jour.* ix. 268.

6. *Chloride of Potassium*.—Mr. Smithson, on examining a mass said to have been thrown out of Vesuvius, found it to be a red ferruginous spongy lava, with here and there a crystal of augite, pyroxine, or hornblende, and containing veins of a white crystalline matter, which, on examination, proved to be chloride of potassium. Mr. Smithson supposes this substance to have been sublimed into the lava.—*Ann. Phil. N. S.* vi. 258.

7. *Chlorine a Remedy in Scarlet Fever*.—Dr. Brown employs chlorine in solution in cases of the scarlet fever, he says with the utmost success. From a tea-spoonful to a table-spoonful is given every two or three hours, without the addition of any other substance. The solution should be fresh and swallowed quickly to avoid coughing; in the sore throat sometimes accompanying the fever, it is more easily swallowed than mucilaginous drinks. As the disease declines, the quantity of medicine is diminished: the whole quantity in the cases of children has never exceeded two ounces, and in adults five ounces.

8. *Effects of the Chloride of Lime as a Disinfecter*.—MM. Orfila, Leseure, Gerdy and Hennelle, having to examine the body of an individual who was supposed to have been poisoned, and who had been dead for nearly a month, found the smell so insupportable that they were induced to try the application of the chloride of lime, as recommended by M. Labarraque. A solution of this substance was frequently sprinkled over the body, and produced quite a wonderful effect, for scarcely had they made a few aspersions when the unpleasant odour was instantly destroyed, and the operation could be proceeded in with comparative comfort.

9. *Use of Sugar as an Antidote to Lead in Cases of Poisoning*.—The following fact has been stated by M. Reynard to the Société des Sciences of Lisle. During the campaign of Russia several loaves of sugar had been enclosed in a chest containing some flasks of extract of lead. One of these flasks having been broken, the liquid escaped, and the sugar became impregnated with it. During the distresses of the campaign it was necessary to have recourse to this sugar; but far from producing the fatal results which were expected, the sugar formed a salutary article of nourishment to those who made use of it,

and gave them a degree of vigour and activity which was of the greatest service in enabling them to support the fatigues of marching. Hence M. Reynard thinks that sugar might be adopted for preventing the effects of subacetate of lead, instead of the sulphates of soda, and of magnesia, which are not always at hand.—*Med. Rep.* xx. 441, or *Journal d'Agriculture*, &c.

10. *Volcanic Eruption in Iceland*.—On the 22d of June last, a great noise began in Myrdals Jokel, on the south side of Iceland, and on the 26th there was a dreadful volcanic eruption from the Crater Kotlugian, which had been quiet since 1775. Pumice and ashes were thrown to a great distance, and even covered ships that were 90 miles from the coast. The ice on the summit of the mountain was torn asunder, prodigious masses rolled into the sea, while torrents of water thrown from the crater covered the adjacent country with mud and slime. There were three distinct eruptions, since which the mountain has been tranquil. This new volcano lies from six to eight leagues to the east of Eyafalle Jokel, which broke out in December last, and about twelve leagues south-east of Hecla.

11. *Periodical Rise and Fall of the Barometer*.—Colonel Wright, member of the Ceylon Literary and Agricultural Society, is said to have discovered that within the tropics, the mercury rises and falls twice within the twenty-four hours, with such regularity as to afford almost an opportunity of measuring the lapse of time by this instrument.

12. *Periodical Thunder Storms*.—Mr. Ronalds has quoted the curious remarks of Volta on the re-appearance of thunder storms for many days together, at the same hour and in the same place. "It is necessary to inhabit a mountainous country, and particularly the neighbourhood of lakes, such as Como, the precincts of Lario, Verbano, Varese, Lugano, Lecco, and the whole mountains of Bianza, Bergama, &c., in order to be convinced of such periods and fixations (so to speak) of thunder storms at this or that valley or opening of a mountain, which last until some wind or remarkable change in the atmosphere shall occur to destroy them." Volta ascribes the effect to a state of the atmosphere produced by the storms of the preceding day.

13. *Voyage of Discovery*.—Capt. Otto von Kotzebue is again about to circumnavigate the world, having already been twice round it. The present expedition is appointed by the Russian government, and is well furnished with every thing that can promote its object. The object is rather to make accurate surveys than new discoveries, but an astronomer, mineralogist, and naturalist, from the University of Dorpat go with it, as well as other scientific men. The instruments are by Troughton and Jones, of London.

14. *Animalculæ of Conferva Comoïdes*.—M. Bose read a report to the Royal Academy of Sciences, in the name of a commission, of a Memoir of M. Gaillon, of Dieppe, relative to that species of marine conferva which M. Decandolle has ranged in the genera *ceramion*, and which Dillwyn has figured under the name of *Conferva Comoïdes*.

M. Gaillon having observed at very short intervals for a whole year the filaments of the *Conferva Comoïde* saw the green corpuscles, which are sometimes ovoïde and sometimes square, and which form the central line, leave the filaments of themselves, move slowly or rapidly, change their direction, and act indeed like the animalcula of infusions, observed by Muller. Then taking entire filaments of the *conferva comoïde*, he forced the animalculæ to separate before their time, and observed the same phenomenon. Such is the necessity of association, that as soon as the young ones can, they place themselves end to end in a line, and then exude a mucus, which, becoming membranous, envelopes them entirely. The bifurcations are formed in the same manner.—*Ann. de Chimie*, xxiv. 208.

LITERARY NOTICES.

Mr. John Curtis has in the press the first No. of his *Illustrations of English Insects*. We understand the intention of the author is to publish highly-finished figures of such species of insects (with the plants upon which they are found,) as constitute the British genera, with accurate representations of the parts on which the characters are founded, and descriptive letter-press to each plate, giving, as far as possible, the habits and economy of the subjects selected. The work will be published monthly, to commence the first of January, 1824.

Mr. Frost intends publishing a *Quarterly Botanical Journal*, with occasional plates.

A geographical, statistical, and historical description of the Empire of China, and its Dependencies: by Julius Klaproth, member of the Asiatic Societies of London and Paris; of the Royal Society of Gottingen; of the Imperial Society of Naturalists, in Moscow; is preparing for publication, in 2 vols., quarto.

ART. XIX.—METEOROLOGICAL DIARY for the Months of September, October and November, 1823, kept at EARL SPENCER'S SEAT at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For September, 1823.										For October, 1823.										For November, 1823.									
Thermo- meter.					Barometer.					Wind.					Thermo- meter.					Barometer.					Wind.				
Low		High		Morn.		Eve.		Morn.		Eve.		Morn.		Eve.		Low		High		Morn.		Eve.		Morn.		Eve.			
1	48	70	30.00	30.03	W	WbS	Wednesday	1	41	28.80	28.90	28.95	N	WSW	Saturday	1	36	41	29.70	29.78	NNE	NW	1	36	41	29.70	29.78	NNE	NW
2	53	66	29.95	29.97	W	W	Thursday	2	33	29.30	29.39	29.45	W	W	Sunday	2	27.5	39	29.46	29.46	NW	NW	2	27.5	39	29.46	29.46	NW	NW
3	48	66	29.90	29.97	W	SW	Friday	3	31.5	29.70	29.70	29.70	W	WSW	Monday	3	27	48	29.85	29.73	W	S	3	27	48	29.85	29.73	W	S
4	54	73	30.04	30.01	SW	NNW	Saturday	4	39	29.88	29.88	29.68	SSE	SSE	Tuesday	4	46	48	30.48	29.37	WS	S	4	46	48	30.48	29.37	WS	S
5	51	72	30.00	30.01	SW	NNW	Sunday	5	58	29.60	29.87	29.87	SSE	SSE	Wednesday	5	93	46	30.49	29.49	SE	E	5	93	46	30.49	29.49	SE	E
6	46	64	30.05	30.02	ENE	E	Tuesday	6	54	29.72	29.70	29.70	W	WSW	Thursday	6	46	53	29.73	29.77	W	EbS	6	46	53	29.73	29.77	W	EbS
7	45	63	30.10	30.11	ENE	E	Wednesday	7	52	29.72	29.70	29.70	W	WSW	Friday	7	47	54	29.80	29.83	W	NW	7	47	54	29.80	29.83	W	NW
8	45	63	30.10	30.11	ENE	E	Thursday	8	59	29.91	29.93	29.93	W	WSW	Saturday	8	42	49	30.03	30.10	WNW	NE	8	42	49	30.03	30.10	WNW	NE
9	32.5	59	30.10	30.17	NNE	NW	Friday	9	56	29.43	29.79	29.79	SW	SW	Sunday	9	42	49	30.26	30.26	ENE	ENE	9	42	49	30.26	30.26	ENE	ENE
10	35	68	30.10	30.10	NW	E	Saturday	10	52	29.32	29.20	29.20	SW	SW	Monday	10	34	45	30.36	30.36	ENE	EbN	10	34	45	30.36	30.36	ENE	EbN
11	41	65	30.18	30.10	E	S	Sunday	11	51	28.80	29.20	29.20	WbS	SW	Tuesday	11	26.5	41	30.44	30.40	ESE	SW	11	26.5	41	30.44	30.40	ESE	SW
12	40	67	29.95	29.88	WbS	S	Tuesday	12	34	29.20	29.27	29.27	ESE	SW	Wednesday	12	23	37	30.36	30.32	WSW	SW	12	23	37	30.36	30.32	WSW	SW
13	52	70	29.95	29.86	S	SW	Wednesday	13	37	29.20	29.27	29.27	ESE	SW	Thursday	13	23	40	30.26	30.32	WSW	SW	13	23	40	30.26	30.32	WSW	SW
14	66	70	29.62	29.48	S	SW	Thursday	14	51	29.32	29.32	29.32	WbS	NW	Friday	14	28	46	30.26	30.32	WbS	WSW	14	28	46	30.26	30.32	WbS	WSW
15	58	65	29.28	29.50	WSW	SW	Friday	15	36	29.24	29.48	29.48	WbS	W	Saturday	15	42	47	30.10	30.12	W	W	15	42	47	30.10	30.12	W	W
16	46	66	29.68	29.77	WbS	SW	Saturday	16	41	29.43	29.45	29.45	WbS	W	Sunday	16	35	43	30.23	30.25	NE	NNW	16	35	43	30.23	30.25	NE	NNW
17	52	64	29.73	29.90	S	NW	Sunday	17	36	29.40	29.49	29.49	E	ENE	Tuesday	17	39	46	30.28	30.38	NE	E	17	39	46	30.28	30.38	NE	E
18	39	62	30.23	30.23	NW	WbN	Monday	18	35	29.16	30.04	30.04	WbN	W	Wednesday	18	42	46	30.07	29.94	E	SW	18	42	46	30.07	29.94	E	SW
19	35	61	30.05	29.98	WbN	WbN	Tuesday	19	39	29.53	29.61	29.61	E	ENE	Thursday	19	41	46	29.87	29.87	SW	WbS	19	41	46	29.87	29.87	SW	WbS
20	41	58	29.78	29.41	W	SW	Wednesday	20	50	29.60	29.60	29.60	E	E	Friday	20	40	49	29.87	29.93	W	WbS	20	40	49	29.87	29.93	W	WbS
21	46	58	29.29	29.80	WNW	SW	Thursday	21	50	29.05	29.05	29.05	ENE	ENE	Saturday	21	42.5	48	30.06	29.75	SW	SW	21	42.5	48	30.06	29.75	SW	SW
22	47	60	29.29	29.80	WNW	SW	Friday	22	49	29.05	29.05	29.05	E	E	Sunday	22	42.5	49	29.80	29.80	SW	SW	22	42.5	49	29.80	29.80	SW	SW
23	39	68	29.74	29.78	W	WSW	Saturday	23	49	29.00	29.94	29.94	ENE	ENE	Monday	23	42	49	29.84	29.80	W	SW	23	42	49	29.84	29.80	W	SW
24	50	65	29.84	29.83	W	WbN	Sunday	24	39	30.13	30.20	30.20	N	NE	Tuesday	24	46	50	30.03	30.03	SW	SW	24	46	50	30.03	30.03	SW	SW
25	54	68	29.73	29.70	W	W	Monday	25	43	30.30	30.20	30.20	SW	W	Wednesday	25	45	47	30.03	30.03	SW	SW	25	45	47	30.03	30.03	SW	SW
26	51	68	29.70	29.72	W	W	Tuesday	26	45	30.12	30.00	30.00	SW	WSW	Thursday	26	44	45.5	29.86	29.78	SW	S	26	44	45.5	29.86	29.78	SW	S
27	39	59	29.50	29.87	W	NNW	Wednesday	27	45	29.50	29.50	29.50	SW	SW	Friday	27	44	45.5	29.51	29.32	SW	S	27	44	45.5	29.51	29.32	SW	S
28	35	57	29.60	29.70	EbN	ESE	Thursday	28	40	29.32	29.08	29.08	E	ENE	Saturday	28	45	52	29.38	29.24	S	SW	28	45	52	29.38	29.24	S	SW
29	30	30	29.22	29.16	S	SW	Friday	29	40	29.22	29.08	29.08	E	ENE	Sunday	29	47	54	29.38	29.24	S	SW	29	47	54	29.38	29.24	S	SW
30	34	50	29.22	29.16	S	SW	Friday	30	36	29.08	29.08	29.08	NE	NE	Sunday	30	47	54	29.38	29.24	S	SW	30	47	54	29.38	29.24	S	SW

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